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THE OPERATIVE TREATMENT OF GLAUCOMA*

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The distinction between glaucoma and cataract was perplexing for many thousands of years. A new light was thrown on the question in 1709, when the will of Bourdelot, court physician of Louis XIV, was carried out after his death. His eyeballs were removed and examined for the character of their disease. It was then that Brisseau found out that the lens was not the seat of the disease called glaucoma. However, he failed to discover the real source of the disease, placing it in the vitreous. His view was adopted by my distinguished predecessor, Joseph Jacob Plenck,[1] the widely known "Professor Regius Publicus ac ordinarius in Regia Universitate Budensi." He stated: "Glaucoma est opacitas humoris vitrei. . . . morbus raris-simus, cognitu dificillimus ac semper incurabilis." ("Glaucoma is an opacity of the vitreous humor. . . . a very rare disease, most difficult to recognize and always incurable.") Joseph Beer,[2] the father of ophthalmology, also regarded glaucoma as incurable. Johannes Theophilus Fabini,[3] professor at the University of Pest in 1831, viewed the matter in a similar light: "Prognosis glaucomatis tristissima est." ("Prognosis in glaucoma is extremely grave.") Nevertheless he pointed to a fact that suggested the real character of the disease: that the elasticity of the eyeball changes so that it becomes as hard as stone. Mackenzie, the great oculist of Glasgow, in 1830, also called attention to the hardness of the glaucomatous eye.

Albrecht von Graefe opened up the true path for the treatment for glaucoma in 1856 by discovering that iridectomy offered indisputable relief to the glaucomatous eye. William Bowmann seemed to be fully justified in making the following remark: "Diese Erfindung war nicht ein zufälliges Raten, sondern ein überlegter Schluss, der stufenweise ausgearbeitet wurde." ("This invention was not an accidental guess, but rather a thoughtful conclusion which was worked out step by step.") The dictum of I. Hirschberg, the great historian and oculist, that "die Iridectomie für Graefe war was für Goethe die Faust-

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1. Plenck, J. J.: Doctrina de morbis oculorum, Venice, 1783.
2. Beer, J.: Lehre von den Augenkrankheiten, Vienna, 1817.
3. Fabini, J. T.: De morbis oculorum.

Dichtung gewesen" ("the iridectomy was for Graefe what 'Faust' had been for Goethe"), is still a living truth.

Von Graefe discovered, by means of careful observation, that all phenomena associated with glaucoma can be explained by the increase in intra-ocular pressure. He further sought means of softening the eyeball. He observed that a staphyloma corneae smoothed down after iridectomy, and he thus discovered that iridectomy reduced the tension of the eye. The results of operations performed for glaucoma exceeded his expectations. The report of his observations rendered at the closing session of the International Ophthalmological Congress in Brussels on Sept. 6, 1857, was received by the audience of ophthalmologists, gathered from all parts of the world, with unanimous admiration. Every one of them seemed to be aware of the fact that they were witnessing one of the greatest and outstanding events of medical progress. Not unlike Alexander the Great, von Graefe achieved the admiration of the world at the age of 30. Such is the privilege of men of genius. Mozart was an immortal composer at the age of 13. Liebig became a professor when he was only 21 years of age. William Pitt was a prime minister in his twenty-fourth year. Napoleon gained the rank of general at the age of 25. Helmholtz discovered the permanence of energy when he was only 26 years of age. Semmelweis was only 23 years of age when he found out the cause and prophylaxis of puerperal fever.

How remarkable von Graefe's power of clinical observation must have been to enable him to point out in his first publications that the prospect of success is in direct proportion to the promptitude with which the operation for glaucoma is performed! No one can fail to be struck by his self-restraint and self-criticism while laying down the limitations concerned with the conquest of glaucoma. He emphasized that "die Iridectomie in der acuten Periode des entzündlichen Glaucoms hat in allen Fällen, wo sie vor Ablauf von 2 Wochen nach dem Eintritt der Entzündung verrichtet wurde, vollständige Wiederherstellung des Schvermögens bewirkt" ("iridectomy always resulted in complete recovery of vision when performed in the acute stage of congestive glaucoma within the first two weeks after the onset of the inflammatory process"). He further stated: "Bei Amaurose mit Schnervenexcavation (i. e., glaucoma simplex) wurde eine Heilwirkung nicht beobachtet." ("I never observed any special curative action in amaurosis with excavation of the optic nerve.")

After the all too early death of von Graefe, his unworthy successors seemed to forget their great master's admirable self-criticism, and almost discredited his great discovery by their exaggerations. The antagonists, the envious and the "would be wiser" wanted to overthrow the foundations of the magnificent edifice constructed by the lucid teachings of

von Graefe. Their theories proved to be erroneous. But as Goethe said, "die Zeit macht nur die feine Gährung kräftig."

The present generation has rendered justice to the memory and merits of von Graefe. The value of iridectomy in cases of acute glaucoma was pointed out at the meeting of the Ophthalmological Section of the International Medical Congress in London in 1913, and was reaffirmed at the Session of the Deutsche Ophthalmologische Gesellschaft in Vienna in 1921. There can be no doubt that iridectomy is efficient and hardly ever fails to bring relief in the prodromal stage of the disease as well as in established acute glaucoma, provided a reduced tension of the eye can still be maintained by the frequent (hourly) instillation of pilocarpine. It is equally indisputable that no good result can be expected by means of iridectomy in the chronic stage of the disease, as had already been admitted by von Graefe. A great number of accessory operations have been suggested for such cases, and the merits and demerits of these have been under constant discussion. The chaotic divergence of views on this subject is increased by the confusion due to an unavoidable vagueness in the terms used for different types and stages of glaucoma. I have often called attention to this wide disagreement in terminology, and have repeatedly emphasized the necessity of clear distinction of terms made on a common basis. My efforts have been in vain, as inexact terminology still prevails. The same terms are still used in different senses by different writers. The recent introduction of new terms makes this chaos still more complicated. Heerfordt, for instance, suggested the distinction between lymphostatic and hemostatic glaucoma. Elschnig spoke of compensated and decompensated cases. They both criticized the use of the term inflammatory or congestive, claiming that one of the most important products of inflammation—exudate—is missing in this process. Fuchs stated long ago, however, that medical terms —when used by members of the profession—need not necessarily indicate the exact pathologic changes, provided there is general agreement as to their meaning. For these reasons it is advisable to adopt the original terminology laid down by von Graefe. He classified primary glaucoma in the following groups:

1. Inflammatory (congestive) glaucoma (glaucoma inflammatorium)
   (*a*) Prodromal stage (in stadio prodromorum)
   (*b*) Acute (acutum)
   (*c*) Chronic (chronicum)
   (*d*) Absolute (absolutum)
   (*e*) Stage of degeneration (in stadio degenerationis)
2. Simple glaucoma (glaucoma simplex)
3. Juvenile glaucoma (glaucoma juvenile)

Special distinction has been made between simple glaucoma and congestive chronic glaucoma. The so-called leading signs are missing in simple glaucoma, or at least they seem to be inconspicuous. A correct diagnosis is reached only through objective data, such as excavation of the optic disk and shrinkage of the visual field. Conditions that never cause the patient to see rainbows around lights or that do not cause transient mists and dilated pupils cannot be classified as simple glaucoma.

It is difficult to form a clear opinion of the effects of different treatments, the more so as medical assistance is often called for in an advanced stage of the disease.

In twenty-five years, 3,472 patients, in whom there were 4,812 glaucomatous eyes, have been admitted and treated in the eye clinic under my direction; 8 per cent appeared for medical treatment within the first week of the attack, and 57 per cent after at least one year had elapsed. Von Graefe stated seventy years ago that "the degree of recovery depends essentially on the length of time the eye has already been affected." If I had included in my statistics glaucomatous patients attending the outpatient service, my figures would prove to be still higher. For example, in 1929, 737 glaucomatous eyes in 378 patients were treated in the outpatient department. Only 32 of the eyes (a little more than 4 per cent) showed the prodromal stage of the disease.

Most of the patients treated for glaucoma in my clinic presented the congestive chronic form of the disease. Drawing a severe distinction between the different types, this would make up 70 per cent of the whole material; in 20 per cent the condition was in the prodromal acute stage. The occurrence of simple glaucoma was about 10 per cent. Juvenile glaucoma was rare, occurring in scarcely 1 per cent. Under the conditions given, operations for congestive chronic glaucoma seem to be the most important for this survey.

It is hardly possible to keep a record of the vast amount of valuable literature on the subject that has appeared within recent years. To review this literature would be a task far transcending the limits of my present undertaking. It is superfluous after the lucid report of my illustrious colleague, Dr. W. H. Wilmer, at Oxford in 1927. Hence I shall present only the course of my own personal experience.

At the beginning of my professional career, when I was assistant professor, the only surgical intervention for glaucoma was iridectomy. After the direction of the I. University Clinic for Ophthalmology was given to me, iridectomy was retained for ten years as the prevailing treatment for glaucoma. The accessory operations were introduced in 1912; Heine's cyclodialysis, the sclerocorneal trephining of Elliot and Lagrange's sclerecto-iridectomy. Within the last sixteen years, 3,553

operations were carried out: 1,897 iridectomies, 600 trephinings, 121 Lagrange operations, 760 cyclodialyses and 175 anterior sclerotomies. These figures indicate that iridectomy maintains an important rôle; while trephining was applied in numerous cases at the beginning, cyclodialysis was performed more frequently at the end of the period. I published the results attained by means of trephinings in Fuchs' Festschrift. The results obtained proved to be favorable, as the tension was reduced to normal in 83 per cent of cases of congestive chronic glaucoma; hypotony followed the operations in 3.5 per cent, and increased tension persisted in only 13 per cent. The results in cases of absolute glaucoma were less favorable, but even among these, 68 per cent were restored to normal tension, while 29 per cent did not react with lowered tension. The fear of late infection hangs like the sword of Damocles over trephined eyes. It is difficult to trace and keep a record of patients suffering from unfavorable results, as they are apt to call on other specialists than those who treated them before operation. This is especially true in cities in which several specialists are available.

The occurrence of general infection may be diminished if the fistula is carefully covered with a flap. It is generally known that trephining is not likely to be successful if performed on eyes with absolute glaucoma. I removed many painful eyes that were utterly blind, in which normal tension had not been restored, and that offered no prospect of recovery after operation. These eyeballs were used to study the reasons for operative failure.

Elschnig and his pupils induced me to perform cyclodialysis on a larger scale. I attempted this operation in 1906 and 1907; as I used it on eyes with absolute glaucoma, the results did not prove to be satisfactory. I have used this operation more frequently since 1920, and at present I can record 692 cases. I obtained favorable results, owing to reduced tension, in 78 per cent of cases of congestive chronic glaucoma. The results proved to be better in simple glaucoma (88 per cent) but less favorable in absolute glaucoma (46 per cent). The supplementary iridectomy mentioned is most advisable in cases of congestive glaucoma.

The uncertain results of these operations are looked on by many with great disfavor. It has been exceedingly difficult for me to form a definite judgment in this matter. A great number of the patients treated in Budapest came from remote parts of the country or from prewar Hungarian territories, and difficulties of transportation often prevented efforts to follow the cases. It was possible to watch the progress of 300 patients for several years. According to the statistics obtained, 65 per cent of the patients operated on for congestive chronic glaucoma showed improvement one year after surgical intervention, 56

per cent were still relieved after the second year and 55 per cent were enjoying favorable results five years after operation. The favorable results (83 per cent) obtained after operation for simple glaucoma decreased to 75 per cent within five years; in patients suffering from absolute glaucoma, the number showing improvement diminished to 18 per cent in three years.

The results of cyclodialysis are favorably influenced by the fact that this operation can be repeated two, three or even four times. The operation was repeated in 14.5 per cent of the cases within one month. If the latter factor is taken into consideration, the statistics given are slightly more favorable. Another great advantage of cyclodialysis is that it involves the least risk. Complete loss of vision hardly ever occurred as a consequence of this operation (0.7 per cent), though most of the patients showed a far advanced stage of glaucoma when first seen. This figure (0.7 per cent) includes also a case of juvenile glaucoma for which the operation proved to be inadequate. If repeated cyclodialysis did not reduce the tension, trephining was performed.

In cases of simple glaucoma sclerecto-iridectomy was usually performed, with the following results: I obtained favorable results due to reduced tension in 94 per cent. Eyesight was unchanged in 92 per cent, better in 5 per cent and worse in 3 per cent. The favorable results decreased to 76 per cent in the years following the operation. The operation was performed only after careful deliberation and only in cases of simple glaucoma in which pilocarpine was still effective in lowering the tension of the eye. In the restriction operations recently introduced there is a much better prospect for improvement.

Anterior sclerotomy is limited to juvenile glaucoma and to the type of eyes on which cataract extraction was formerly performed by means of iridectomy and in which, though the iris was not entangled in the scar, glaucoma nevertheless developed.

Surgical intervention is always aided postoperatively by protracted miosis produced by frequent instillations (from two to fifteen times a day) of a 2 per cent solution of pilocarpine. Special care is given to general treatment after operation. As time passes, however, I feel more and more confident that surgical aid is so far the most effective means for the relief of glaucoma. Some cases are on record in which the glaucomatous process was long held at bay by carefully conducted miotic treatment. A number of such cases were recorded by my predecessor, Prof. Dr. Vilmos Schulek. I observed eyes in which the condition was held in check by means of pilocarpine for thirty-five years, but which could not be prevented from ending in an attack. One of my former assistants, Dr. Joseph Imre, applied organotherapeutics with favorable

results, but his cases were regarded as exceptional. The prevailing method of intervention is still the operative one.

With regard to the adequacy of operations performed for different kinds of glaucoma, the following principles are borne in mind at the Budapest University Eye Clinic under my direction:

Inflammatory glaucoma, prodromal and acute stage: iridectomy (von Graefe)
Chronic inflammatory glaucoma: cyclodialysis (Heine); trephining (Elliot)
Glaucoma simplex: iridosclerectomy (Lagrange)
Juvenile glaucoma: anterior sclerotomy (Wecker)
Glaucoma degenerative stage: enucleation (Arlt)

The successful treatment for glaucoma is not merely a scientific problem, but just as much a cultural and a social one. It is still the most frequent disease of the eye ending in permanent blindness (15 per cent), being more frequent than atrophy of the optic nerve, ophthalmia or trachoma.

The most effective weapons for the conquest of glaucoma are the education of communities, postgraduate medical instruction, the decentralization of ophthalmologists and the establishment of hospitals and of wards in hospitals situated in the country for patients with diseases of the eye.

These principles were always kept in view in Hungary before the World War. The eye hospitals established in Zsolna, Brassó, Szeged and Perlak and special wards in other hospitals were all united in the fight against blindness, especially that caused by glaucoma; 1,200 beds were available for this work. Four governmental eye hospitals and several eye wards were situated in territories turned over to other countries; all these were indisputable evidence of the fact that special care was being taken to provide for the cultural needs and public welfare of the entire population.

Mutilated Hungary is again offering 1,200 beds—including all the recently established ones—for the relief of people suffering from diseases of the eye.

CHRONIC CISTERNAL ARACHNOIDITIS PRODUCING SYMPTOMS OF INVOLVEMENT OF THE OPTIC NERVES AND CHIASM

PATHOLOGY AND RESULTS OF OPERATIVE TREATMENT IN FOUR CASES *

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The discovery during the past years of an increasing number of pathologic conditions that may involve the optic nerves and chiasm and give rise to the clinical manifestations of optic atrophy, visual disturbances and perimetric field defects has constituted one of the most important advances in knowledge of the pathology, diagnosis and treatment of lesions about the optic chiasm. Following the reports of Marie and Fröhlich concerning the association of pituitary tumor with the clinical pictures of acromegaly and dystrophia adiposogenitalis, respectively, the attention of clinicians and surgeons was focused on these tumors, and in their diagnosis certain signs and symptoms were more or less insisted on. These included "sellar" headaches, subjective visual disturbances, primary optic atrophy, bitemporal hemianopia, an expanded sella turcica, with or without destruction of the clinoid processes, and metabolic disturbances indicated by acromegaly or Fröhlich's disease. It was appreciated that certain other signs and symptoms indicative of the wide intracranial expansion of the growth might be present, such as ptosis, ocular palsies and uncinate seizures. As experience with the primary hypophyseal tumors grew, it was recognized that some of them might be unassociated with evidences of glandular disturbance (i. e., chromophobe adenomas without signs of Fröhlich's disease), so that signs of glandular derangement were no longer considered essential in their diagnoses. Later it was recognized that pathologic conditions other than primary hypophyseal tumors may involve the optic chiasm, among which the suprasellar craniopharyngiomas, the suprasellar and parasellar meningiomas, some of the gliomas of the optic chiasm and certain of the suprasellar aneurysms, in their earlier stages at least, not only might not be associated with glandular symptoms but might occur in the total absence of any abnormalities of the sella turcica as seen in the roentgenogram. Their characteristic clinical features are now recognized

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to consist of visual disturbances, primary optic atrophy and bitemporal visual field defects, a group of symptoms to which Cushing applied the term "chiasmal syndrome." Certain other conditions, among which may be the prechiasmal tumors of the optic nerves described by Dandy and the condition of chronic cisternal arachnoiditis which we are discussing, may fail to produce characteristic bitemporal field defects and present simply primary optic atrophy and its concomitant constricted field of vision. Therefore, primary optic atrophy alone, in the absence of any other clinical manifestation of disease, may be a positive indication for operation directed toward the relief of pressure on the optic chiasm and nerves.

This statement sounds radical, but it is not so intended. It is intended to call to the attention of ophthalmologists, particularly, the surgical possibilities in certain cases included under the heading of primary optic atrophy without a positive etiologic factor and without roentgen or other evidence of a lesion about the optic chiasm. It also raises the question, so often discussed with reference to papilledema or choked disk, whether so-called primary optic atrophy is chiefly due to mechanical causes and therefore is amenable to surgical measures, or whether it is more commonly due to inflammatory, toxic or other causes. This question cannot be satisfactorily answered. The neurosurgeon's experience is overwhelmingly in favor of the mechanical cause of optic atrophy: either primary, the result of direct pressure on the optic chiasm or nerves, or secondary, the result of a previous choked disk. The ophthalmologist's experience may be quite different. Among forty-three cases of primary optic atrophy seen by one of us (D. T. V.) in the past five years, twenty-one, or 49 per cent, were due to syphilis (dementia paralytica in most instances); ten, or 23 per cent, to pituitary or suprasellar tumor; three, or 7 per cent, to basilar fractures; two each (5— per cent), to chronic cisternal arachnoiditis and glioma of the chiasm, and one each (3— per cent), to multiple sclerosis and methyl alcohol poisoning. In three cases the etiology was not determined. In this series seventeen, or 40 per cent, of the cases were due to mechanical causes. Bigland, in a review of fifty-six cases of primary optic atrophy, found that fifteen or 27 per cent were due to syphilis (late syphilis or dementia paralytica); ten or 18 per cent to pressure on the optic chiasm. thirteen or 23 per cent to retrobulbar or axial neuritis and eight or 14 per cent to miscellaneous causes. In ten cases an etiologic factor was not found. Other statistics from ophthalmologic sources show a considerable variation in the etiologic factors responsible for the condition. A review of various textbooks on ophthalmology shows how great a variety of etiologic factors are supposed to be concerned in the causation of primary optic atrophy. Among cerebrospinal diseases are

included tabes, dementia paralytica, disseminated sclerosis, lateral sclerosis, chronic myelitis, syringomyelia and pseudobulbar paralysis. Among hereditary diseases associated with hereditary optic atrophy are mentioned Leber's disease, oxycephaly, marble bone disease and amaurotic family idiocy. Inflammatory and traumatic conditions, chemical poisons such as methyl alcohol, lead and arsenic, vascular conditions such as arteriosclerosis, aneurysms, thrombosis and embolism, diabetes and neoplasms of or about the optic chiasm are included in the causes; nor does this long list exhaust the possibilities. Nevertheless, there emerges from almost every large series two groups of cases which may be of interest in that they may be examples of the condition under discussion, i. e., the large group of cases diagnosed as syphilitic and the fairly large group in which the cause is stated as unknown. It seems possible that among these two groups, perhaps also in others, there may be a considerable number of cases of chronic cisternal arachnoiditis.

REPORT OF CASES

Four cases of this condition in which operation was performed are reported here; a description of the pathologic process, as seen at the operating table, and the results of treatment follow.

CASE 1.—L. H., a white man, aged 25, was admitted to the Cincinnati General Hospital on Feb. 17, 1927, complaining of failing vision. In May, 1926, he first noticed that he was unable to read ordinary print. He consulted an oculist who prescribed glasses which seemed to improve his vision temporarily. By September, 1926, he was unable to read and could see objects only 3 feet (91 cm.) away. He entered a hospital about this time, where his treatment consisted of "shots" in the arm following a diagnostic lumbar puncture. His vision again improved for a time and then declined. He had been subject to frontal headaches and occasionally to "sick headaches" since May, 1926, sometimes associated with vomiting. He sometimes had a ringing in his left ear like the "sound of a bell." Otherwise there had not been any noteworthy symptoms.

A possible etiologic factor was a fall from a hay-loft seven years before admission to the hospital. He received an injury to the back of his head and was totally unconscious for two days. He had a slow recovery and suffered with severe frontal headaches during this period.

Examination revealed an intelligent, cooperative young man, apparently in good health. A general physical examination gave entirely negative results, except that his feet were unduly small and short; the arch was high and the toes strongly flexed ventrally as in "hammer toe." According to his father, this was a congenital abnormality. Neurologic examination yielded entirely negative results except for the ocular symptoms. Vision was markedly impaired. He was unable to read any print; the best he could do was to count fingers at 4 feet (122 cm.). Ophthalmoscopic examination showed typical primary optic atrophy. The perimetric fields taken with a large white disk (2.5 cm.) showed a constriction of the visual fields, particularly in the temporal field of each eye, together with an enlarged blind spot. Color was recognized if it appeared in large masses (fig. 1). The sella turcica was normal in size and configuration. There was no evidence

of hypophyseal dysfunction. A ventriculogram showed the ventricles of normal size and in normal position. Lumbar punctures, performed on Feb. 20 and 21, 1927, showed the spinal fluid under 21 cm. of pressure and perfectly clear, but containing from 75 to 80 cells per cubic millimeter, mostly lymphocytes. The Wassermann reactions of the spinal fluid and blood were negative.

Comment.—The patient gave a history of severe cranial injury seven years previously; ten months before admission to the hospital, he began to lose his vision. He had subjective headaches and occasionally ringing in his ears, but otherwise no neurologic features except optic atrophy and suggestive bitemporal field defects. The spinal fluid, however, was under slightly increased pressure and contained an abnormal number of cells; this, together with the history of a severe cranial injury

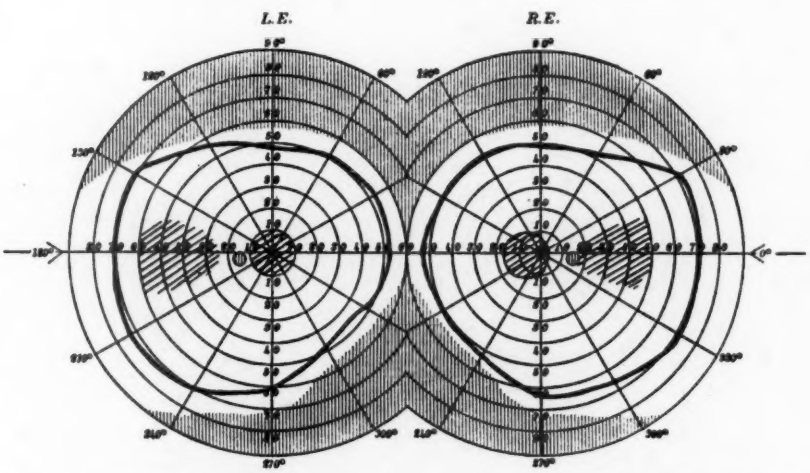

Fig. 1 (case 1).—Perimetric fields taken (by D. T. V.) before operation with a 2.5 cm. white disk. The enlarged blind spots and area of impaired vision are shaded. The temporal fields, especially, are constricted. Large masses of color were recognized but were not charted.

followed by headaches, suggested a condition that not uncommonly follows fracture of the skull and that, for want of a better term, has been called chronic serous meningitis or chronic arachnoiditis. The condition may be a general one, in the sense that it may not give rise to focal symptoms, or it may be localized, as for example, over the cerebellum, and give rise to focal symptoms as clearly defined as those due to tumor of the brain. The patient's symptoms, then, might be explained as due to a localized process involving the chiasm. While a positive diagnosis of localized chronic cisternal arachnoiditis involving the optic chiasm was not made in this case, the possibility of this condition was laid before the patient and an exploration of the chiasmal region suggested. The patient agreed to an exploratory craniotomy.

Operation (March 7, 1927).—A large fronto-temporoparietal bone flap was reflected on the right side, following the method of exposing the chiasmal region previously described by one of us (G. J. H.). The dura was under moderate tension. A dural flap about as large as the bone flap was reflected posteriorly. The pia-arachnoid over the whole area of the brain exposed was much thickened and grayish white. Beneath it was a large amount of cerebrospinal fluid, which escaped in quantities when the tough pia-arachnoid was torn with a needle. After some of the fluid was evacuated, the base of the frontal lobe was gently elevated until the optic chiasm and nerves came into view. It was immediately apparent that there was a mass of adhesions about the anterior part of the chiasm, which continued forward around the optic nerves. The cisterna chiasmatis was distended with fluid, and its wall was thickened and opaque. The cistern was broken into between the tuberculum sellae and the chiasm, and a large amount of clear cerebrospinal fluid escaped. As much of the wall of the cistern as possible was

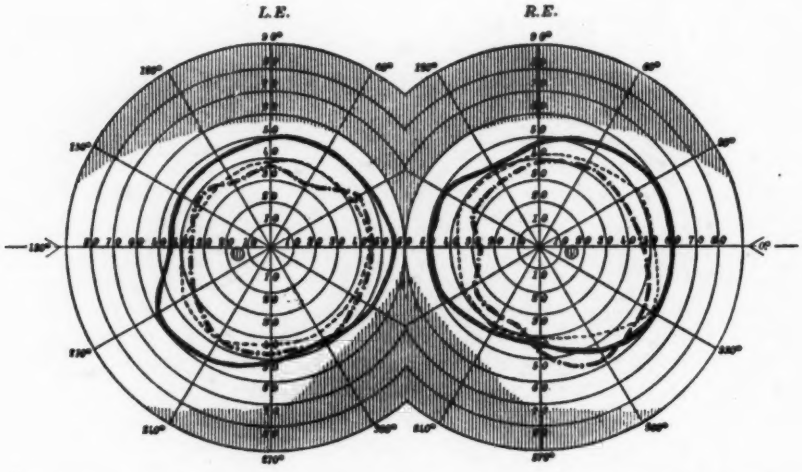

Fig. 2 (case 1).—Perimetric fields taken by Dr. H. Glenn Bell with 5 mm. disks two weeks after operation. Compare with figure 1. The solid line shows the field for white, the dotted line the field for red, and the dash line the field for blue.

snipped away with scissors. With a blunt dissector the adhesions around the optic nerves were separated so as to free the nerves as much as possible. They appeared attenuated and grayish. After these manipulations were completed, it was possible to elevate the chiasm so that one could look into the sella turcica and see the diaphragma sellae. Nothing suggesting a tumor was seen about the chiasm. The bone flap was replaced and the wound closed in layers with silk.

Postoperative History.—The patient had a smooth convalescence without any postoperative complications. The wound healed per primam. During his stay in the hospital he stated that subjectively his vision had improved. He was discharged on March 23. On the day of his discharge he was able to count fingers easily at 8 feet (243 cm.). His visual fields, taken with a 5 mm. disk, showed about the same limits of vision as they showed previously with a 2.5 cm. disk (fig. 2).

The patient was seen by one of us (D. T. V.) on April 26. At that time vision had improved subjectively. Objectively he could count fingers at 12 feet (365 cm.), and was able to read large print. On perimetric examination with a 1 mm. disk (fig. 3) there remained a temporal constriction of the field in each eye. The central scotoma and enlarged blind spot in each eye were smaller. The headaches had disappeared. From this time the patient's vision slowly but steadily improved. On July 17, 1928, one and one-half years after operation, the following note was made (by D. T. V.): "Visual acuity, both eyes, 20/30+. The patient can easily read ordinary print, but reads the finest print with difficulty. The perimetric examination shows constriction, principally in the temporal fields" (fig. 3). Following the examination the patient moved to another city, and no subsequent examination was made. A letter, however, dated Jan. 7, 1930 (three years after operation), stated that his vision had remained about as it was in July, 1928. He could read and had good vision for ordinary work, and his headaches had not returned.

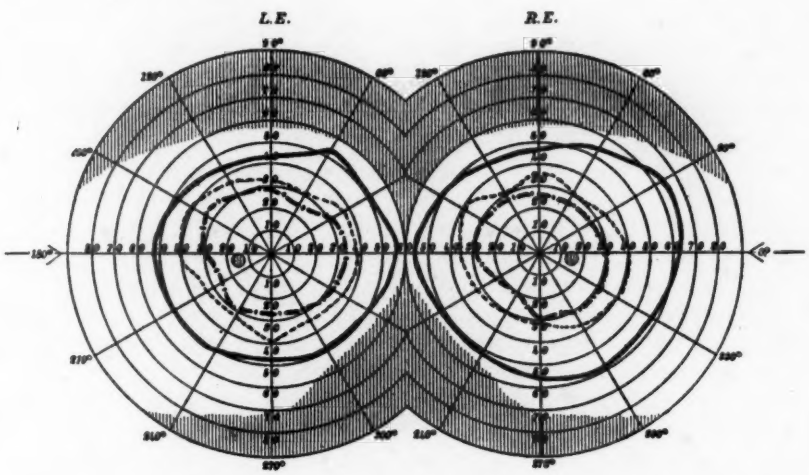

Fig. 3 (case 1).—Perimetric fields taken (by D. T. V.) with a 1 mm. disk one and one-half years after operation. Visual acuity was 20/30+ in both eyes. The patient read fine print. The solid line shows the field for white, the dotted line the field for red, and the dash line the field for blue.

CASE 2.—E. T., a nurse in training at the Bethesda Hospital, was admitted to the hospital as a patient on March 10, 1929, under the care of Dr. Frank Phinney of Cincinnati. Her case is to be fully reported by Dr. Phinney at a forthcoming meeting of the American Ophthalmological Association, and only the briefest notes will be given here. Her complaint was failing vision. A series of tests for visual acuity and perimetric examinations made by Dr. Phinney between January and March, 1929, showed that vision had gradually declined from 20/50 in the right eye and 20/100 in the left to 20/100 in the right and 20/200 in the left; the visual fields had gradually contracted to an area of central vision of 15 degrees on the right and 10 degrees on the left. The fundi showed a white atrophic disk like that seen in primary optic atrophy. Aside from subjective and objective loss of vision, optic atrophy and perimetric field changes, there were no abnormal symptoms or physical signs. The sella turcica was normal. There

was no suggestion of hypophyseal dysfunction. The Wassermann reactions of the blood and spinal fluid were negative. Dr. Phinney referred the patient to one of us (G. J. H.), and in view of our experience with case 1 an exploration of the chiasmal region was suggested.

Operation (March 11, 1929).—A large fronto-temporoparietal bone flap was reflected as in case 1. The dura was under slight tension. A dural flap about as large as the bone flap was reflected posteriorly. The pia-arachnoid was slightly opalescent and thickened but in no sense to the degree present in case 1. Beneath it was a large amount of cerebrospinal fluid which "sweated" through it as is often seen in the exposure of the cortex of epileptic persons. The convolutions appeared narrower than normal, and the clefts between them wider. With a needle, rents were made in the pia and a quantity of clear cerebrospinal fluid escaped. The base of the frontal lobe was elevated with a broad spatula until the optic nerves and chiasm came into view. There were no adhesions about the optic nerves or chiasm, but the cisterna chiasmatis was distended with fluid and its wall was thickened. A rent was made in it with a blunt dissector and a considerable amount of cerebrospinal fluid escaped. With the collapse of the cistern one could look into the sella turcica and see the sellar diaphragm. Careful exploration of the region about the chiasm failed to reveal any evidence of a tumor. The dural and bone flaps were replaced and sutured. The patient had an uninterrupted recovery and was discharged on March 30.

Subsequent History.—There was a gradual improvement in vision so that the patient was able to return to her work. She was last seen by one of us (G. J. H.) on March 13, 1930 (one year after operation). She had gained 25 pounds (11.3 Kg.) and stated that she felt well; she had previously been underweight. The scar was practically invisible. The pupils were equal and reacted promptly to light. There was no hemianopia on rough tests. A restriction of the left visual field was obvious. On ophthalmoscopic examination, the optic disks appeared distinctly less pale than previously. With the glasses she was wearing she read the finest print with ease. (The visual fields of this patient will doubtless appear in Dr. Phinney's report.)

Case 3.—Mrs. M. C., a white woman, aged 45, after having consulted one of us (D. T. V.), was admitted to the Holmes Hospital on Nov. 4, 1929, complaining of total blindness. Two weeks before she was first observed, she noticed that her vision was obscured. She volunteered the information that when looking at objects or persons she saw only the inner and not the outer side of them, which suggested strongly a temporal hemianopia. Color vision, she noticed, disappeared a week after the onset of the visual disturbance. Her eyesight declined so rapidly that at the time of first examination she was practically blind. Meanwhile, her only other symptoms were occasional headaches, one attack of vomiting and several attacks of dizziness during the past month. There was no history of trauma, infection of the ears or sinuses or any other possible etiologic factor.

Examination showed a well nourished, healthy-looking woman without complaint except that she could not see. There was nothing in her appearance to suggest a pituitary disturbance, and laboratory tests to determine a possible pituitary dysfunction were negative. The Wassermann reactions of the blood and spinal fluid were negative. Neurologic examination, except for the ocular symptoms, gave entirely negative results. The sella turcica was normal in size and configuration. The pupils were wide and equal and failed to react to ordinary light. When the bright light of an ophthalmoscope was thrown into the eye there was possibly a slight reaction. Examination of the fundi showed a pale atrophic

disk. One of us (D. T. V.) thought that a superimposed slight edema of the nasal margins was present. The patient was evidently completely blind. She recognized the difference between ordinary light and the bright light of the ophthalmoscope when it was directed into the eye, but beyond that, nothing. Visual fields could not be taken. A tentative diagnosis of chronic cisternal arachnoiditis was made and an exploration of the chiasmal region advised. To this she consented.

Operation (Nov. 6, 1929).—A large osteocutaneous flap was turned back as in cases 1 and 2. The dura was under moderate tension. A large dural flap was reflected posteriorly. The pia-arachnoid over the entire surface of the brain exposed was thickened and opaque. Beneath it was an excessive amount of cerebrospinal fluid which escaped in quantities through rents made in the tough membrane. A ventricular puncture allowed the escape of a larger amount of cerebrospinal fluid than was considered to be normal. With a spatula the base of the

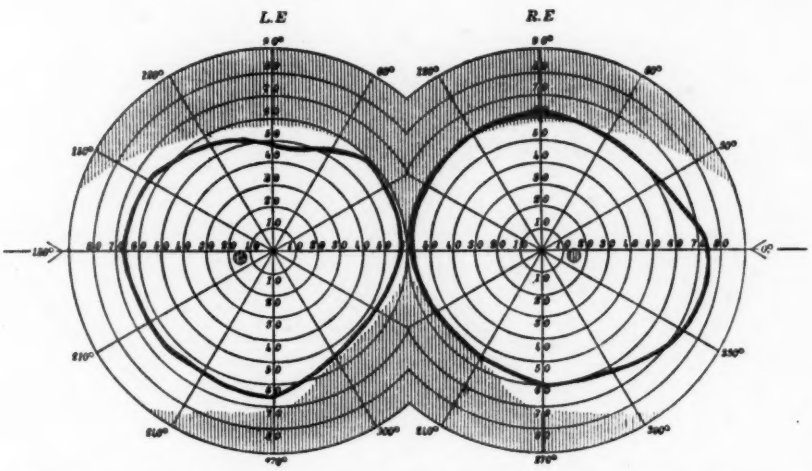

Fig. 4 (case 3).—Visual fields taken with a 2.5 cm. white disk twelve days after operation. The temporal fields were somewhat constricted. Colors were not recognized.

right frontal lobe was elevated until the optic nerves and chiasm were brought into view. There were adhesions about the anterior border of the chiasm and sella which extended forward around the optic nerves. The wall of the cistern was thickened, opaque and bulging with fluid. The cistern was opened with a blunt instrument, the fluid was evacuated and such portions of its wall as could be grasped were cut away with scissors. The adhesions about the optic nerves were separated by blunt dissection. After the nerves were freed they appeared grayish and attenuated. There was no evidence of a tumor. The dural and bone flaps were replaced and sutured. The patient made an excellent recovery.

Postoperative History.—Vision began to return within twenty-four hours after operation. Three days after operation the patient could count fingers at a distance of 2 feet (60 cm.). Eleven days after operation the visual fields, taken with a white disk, 2.5 cm. in diameter, showed a fairly normal relationship except for restriction in the temporal field of each eye (fig. 4). Colors were not recognized.

The patient was seen by one of us (D. T. V.) on Sept. 4, 1930, eleven months after operation. The vision in the right eye with correction was 20/30+, and that in the left eye with correction, 20/30—. In both eyes vision was 20/20— 1. She was able to read the finest print with ease. Both optic disks were grayish white. The lamina cribrosa was plainly visible and the blood vessels were normal in size and caliber. The outline of the disk was well preserved in each eye. The fields of vision with a 1 mm. disk showed a normal periphery. She was able to name large color objects in the center, but was unable to name the small red and green colors in the Heitz chart. Color fields in the periphery were normal.

Case 4.—W. P., a colored girl, aged 14, was admitted to the Cincinnati General Hospital on Nov. 8, 1929, complaining of convulsions, impairment of vision and pain in the abdomen. According to her story, corroborated by her sister, her illness began two weeks before admission, with a severe headache followed by nausea. She attempted to vomit and, while doing so, "went into a spell," with

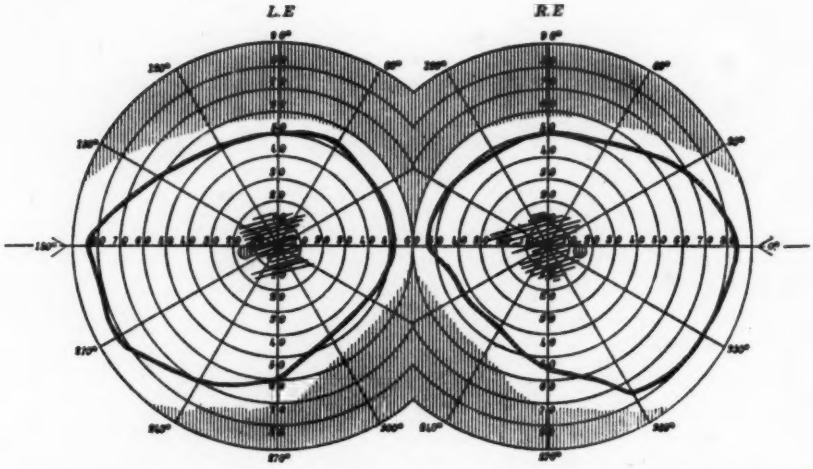

Fig. 5 (case 3).—Visual fields taken (by D. T. V.) with a 1 mm. object five months after operation. The shaded areas in the center of the fields represent the central scotoma for red and green. Colors were recognized elsewhere but were not charted.

stiffness of the body and tremor of the extremities. Her head was thrown back and her arms and legs were rigid. The attack lasted for one-half hour. In the two weeks before admission she had five attacks of this kind followed, on the night of her admission to the hospital, by a series of attacks in none of which, however, did she lose consciousness. She was admitted to the medical and neurologic services of the hospital. In the first forty-eight hours on the ward, she had forty-six convulsions. These lasted from five to ten minutes. Observers noted that the left arm and leg became rigid and sometimes showed clonic movements while the right side remained flaccid. In the more severe attacks there was loss of consciousness but no incontinence or biting of the tongue.

The history of impairment of vision could not accurately be obtained. The patient was aware that recently her vision had not been good, but could not give an exact date regarding its loss. She was vague also about the abdominal pain, which she located in various areas, chiefly in the epigastrium and the lower right

quadrant. As a possible etiologic factor, her sister stated that at the age of 5 years the patient had a serious illness called "a stroke of rheumatism" associated with fever and pain in the left ankle and knee. She was unable to walk and had been weak on the left side ever since. Her mouth was "twisted to one side" during this illness.

The patient was fat, distinctly dull and apathetic and not cooperative. She was, however, mentally clear and understood and answered all questions. A general physical examination gave negative results. The thyroid gland was not palpable. The heart and lungs were clear. The temperature before operation was usually subnormal, although it occasionally rose to 99 or 100 F. Her pulse rate varied between 70 and 90. The abdomen was generally tender, but repeated examinations failed to show any rigidity of the muscles, local tenderness or abnormal masses. Pelvic examination yielded negative results. There was increased tonus and spasticity of the left arm and leg. The toes of the left foot were deformed, the

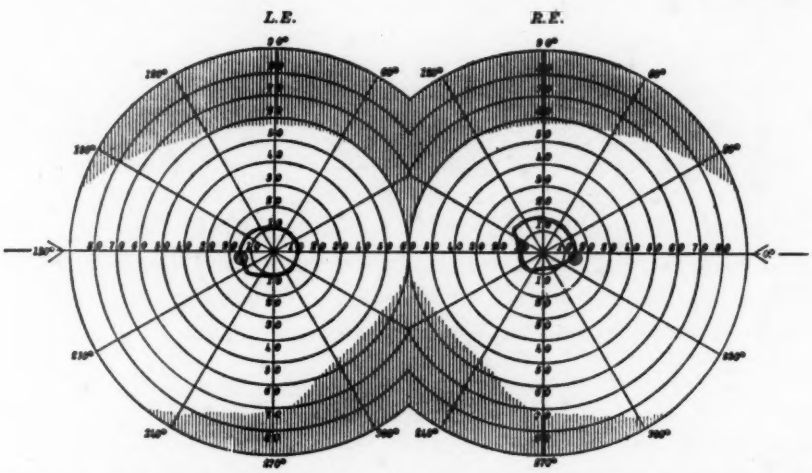

Fig. 6 (case 4).—Visual fields before operation taken with a 5 mm. white disk by Dr. Goode. Colors were not recognized. Visual acuity was not accurately determined. The patient was totally unable to read print (even large headlines) and counted fingers with difficulty.

condition resembling the "hammer toe" deformity (curiously enough, the patient in case 1 had a similar deformity).

Neurologic examination revealed the following positive features: mental dulness, apathy and lack of interest in surroundings; diplopia without demonstrable weakness of the eye muscles; increased muscle tone, with slight spasticity and weakness of the left arm and leg; a positive Romberg sign and absent abdominal reflexes. The pupils were wide and equal; they reacted sluggishly to light. The disks were extremely pale and presented the picture of primary optic atrophy. Dr. Ray (ophthalmologist) noted slight superimposed edema of the left disk, not noted by a number of other observers, among them one of us (G. J. H.). The visual acuity could not be tested accurately. The patient was totally unable to read ordinary large print and could count fingers only with difficulty. Colors apparently were not recognized. The visual fields, taken with a 5 mm. white disk, showed a marked constriction, in general concentric, but with a suggestive hemianopic defect in the inferior field of the right eye (fig. 6).

Physically, the patient presented many of the characteristics of Fröhlich's disease. She was very fat and had unusually large and pendulous breasts, a marked abdominal panniculus and pads of fat over the hips. She was dull and apathetic, her temperature was usually subnormal, and her basal metabolic rate was minus 8. Her sugar tolerance was, however, within normal limits. She had menstruated irregularly once or twice a year before, but since then there had been complete amenorrhea.

Roentgenograms of the skull showed a perfectly outlined sella turcica, smaller than normal and without destruction of the clinoid processes. Lateral and anteroposterior stereoscopic roentgenograms of the skull, made after the injection of air (encephalograms), showed the ventricles to be of normal size, without distortion and in normal relationship to one another.

The spinal fluid was clear and under 15 cm. of pressure; it contained 3 cells per cubic millimeter. The globulin test was negative. The Wassermann reactions of the blood and spinal fluid were negative.

Comment.—This case presented a more complicated picture than the three preceding cases. The patient presented the clinical manifestations of headache, sexual infantilism (in the absence of deformation of the sella turcica), jacksonian epilepsy, and spasticity and weakness of the left arm and leg, indicative of a right-sided cortical lesion. Chronic arachnoiditis, probably more or less generalized but producing local symptoms with reference to the right precentral and chiasmal regions, explained the clinical picture perhaps better than any other condition and this diagnosis was made. Operation was advised.

Operation (by Dr. Andrus, April 2, 1930).—A fronto-temporoparietal bone flap was reflected sufficiently to expose the right motor strip and chiasmal region. A dural flap of equal size was reflected posteriorly. The pia-arachnoid over the whole area exposed was markedly thickened and opaque and generally distended with fluid. Over the motor strip, however, was a thick mass of tissue involving the pia-arachnoid, evidently the result of a previous inflammatory process, which was densely adherent to the overlying dura and the underlying cortex over a considerable area. This lesion clearly explained the jacksonian attacks and weakness of the left arm and leg. This mass of tissue was freed from the overlying dura, and as much as possible of it was excised. Rents were made in the thickened pia here and there over the exposed brain, and a large amount of cerebrospinal fluid was evacuated. A ventricular puncture also helped to reduce the volume of the brain and make the exposure of the optic chiasm more easy. With a broad spatula the base of the frontal lobe was elevated and the optic nerves and chiasm brought into view. The cisterna chiasmatis was bulging with fluid and its wall was thickened and opaque. There was a mass of adhesions surrounding each optic nerve, which extended from the chiasm to the optic foramina. The adhesions fixed the chiasm along the anterior border of the sella and the optic nerves to the dura covering the base of the skull. The cisterna chiasmatis was broken into and evacuated, and a part of its anterior wall was snipped away with scissors. The optic nerves were freed from adhesions by blunt dissection. The dura was replaced and sutured, and a small decompression opening was made in the temporal region before the bone flap was replaced and sutured. Convalescence was uninterrupted and satisfactory. The wound healed per primam. The patient

was discharged free from headaches and generally improved with respect to her mental condition. She had no epileptic attacks after operation.

The patient was last seen on May 15 (one and one-half months after operation). Her mental condition was much improved. She was more alert and much brighter. Her vision was greatly improved. Before operation she could not read at all. Now she read ordinary print with ease, but had difficulty in reading the finest print. Her visual fields, taken with a 1 mm. white disk, showed a greatly widened field of vision with the disappearance of the suggestive inferior defect in the right field noted before operation (fig. 7).

Comment.—Chronic arachnoiditis or arachnitis affecting the brain and spinal cord is well known. It may occur as a localized or a generalized process. The earliest description of a localized process was apparently that by Schlesinger [1] in 1898; this was followed by articles by Spiller, Musser and Martin [2] and others. The generalized form was first

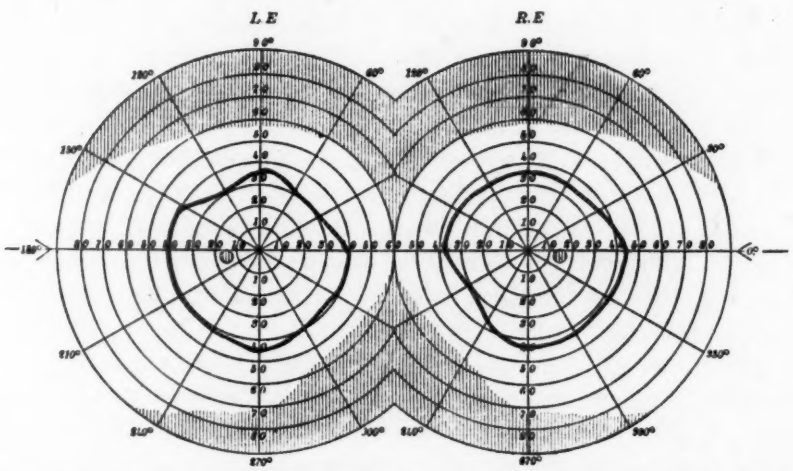

Fig. 7 (case 4).—Visual fields taken by Dr. Goode with a 1 mm. white object one and one-half months after operation. The widening of the visual fields may be seen by comparison with figure 6. Colors were recognized but unfortunately were not charted. The patient could read ordinary print with ease.

described by Quincke [3] in 1893 under the term of "meningitis serosa," and since then comprehensive reviews of the whole subject have been published by Mendel and Adler,[4] Muskens,[5] Nonne [6] and Schulthuss.[7]

1. Schlesinger: Beiträge zur Kenntnis der Rückenmarks- und Wirbeltumoren, Jena, Gustav Fischer, 1898, pp. 46-162.
2. Spiller; Musser, and Martin: Univ. Pennsylvania M. Bull., March-April, 1903, vol. 16.
3. Quincke: Ztschr. f. Nervenh. **9**:149, 1897.
4. Mendel and Adler: Berl. klin. Wchnschr. **45**:1596, 1908.
5. Muskens: Deutsche Ztschr. f. Nervenh. **39**:421, 1910.
6. Nonne: Die allgemeine Chirurgie der Gehirnkrankheiten, 1914, vol. 2, p. 105.
7. Schulthuss: Dissert., Wiesbaden, 1919.

More recently Horrax[8] published from Cushing's clinic an excellent paper on generalized cisternal arachnoiditis simulating cerebellar tumor; he reported thirty-three cases subjected to operation, with the pathologic process found and the late results obtained. It is not our purpose to discuss the condition in its various manifestations; instead we will confine our comments to that particular form of arachnoiditis which involves the region of the optic chiasm and gives rise to thickening of the wall of the cisterna chiasmatis and to adhesions involving the optic chiasm and nerves. The literature on this particular form is meager. In reviewing reported series of hypophyseal tumors we found an occasional case which showed symptoms of pituitary tumor, but which at operation failed to show any evidence of tumor; the presumption is that these may have been examples of the condition that we are discussing. McArthur, Hirsch, Cushing and others reported cases of this type, but, with the exception of Cushing, they did not make any particular comment on them. Cushing[9] included the condition among a group of pathologic lesions giving rise to the chiasmal syndrome of primary optic atrophy and bitemporal field defects in adults with a normal sella turcica. He reported only one case subjected to operation, but it is evident that he had observed a number of similar cases. With this exception we fail to find the condition discussed from the point of view of giving rise to clinical symptoms referrable particularly to pressure on the optic chiasm and nerves and urgently demanding operative intervention.[10]

The frequency of the condition is not known. In such tabulations of pathologic conditions giving rise to symptoms of chiasmal involvement as are available in the literature, the condition is usually not mentioned. In our own experience chronic arachnoiditis involving the cisterna chiasmatis and producing adhesions about the optic chiasm and nerves is relatively common. In the experience of one of us (G. J. H.) in Baltimore the condition was not observed in twenty-four successive exposures of the chiasmal region by the intracranial route, but in our experience in Cincinnati the condition was observed four times in seventeen recent successive exposures of the chiasmal region. No conclusion can be drawn from so small a series of cases, but we have the impression that the condition is more common than is generally realized. Moreover, there seems to be a strong possibility that the condition is the pathologic cause of some of the more obscure diseases

8. Horrax, G.: Generalized Cisternal Arachnoiditis Simulating Cerebellar Tumor, Arch. Surg. **9**:95 (July) 1924.

9. Cushing: Thirteenth Ophthalmological Congress, Holland, 1929.

10. Davis, L., and Haven, H. A.: A Clinico-Pathologic Study of the Intracranial Arachnoid Membrane, J. Nerv. & Ment. Dis. **73**:286 (March) 1931.

associated with primary optic atrophy; for example, in a case of Leber's disease (one of the groups of so-called hereditary optic atrophies) occurring in the practice of Dr. Kuhn this condition was found by Dr. Loyal Davis on exploring the chiasmal region. At any rate, our experience suggests that surgical measures be considered more seriously than they have been in the past in cases of primary optic atrophy that obviously are not due to primary pituitary tumor or any other well known etiologic factor.

The etiology of the condition also is not well established. In the experience of one of us (G. J. H.) with chronic arachnoiditis in all its manifestations it is clear that when an etiologic factor is present it falls into one of two groups: an antecedent trauma (fracture of the skull or the spine) or an antecedent infection. The infections are of two kinds: an infection of the meninges or brain (encephalitis, meningo-encephalitis, leptomeningo-encephalitis) or an infection of an area adjacent to the brain (the middle ear, mastoid or various sinuses). Most writers on the subject of chronic arachnoiditis have noted the same possible etiologic factors. Among the four cases that we have reported a severe cranial trauma was the possible etiologic factor in case 1 and encephalitis in case 4. In two cases no etiologic factor could be determined.

The pathologic process, so far as macroscopic appearances go, has been described by many writers on the subject, and their descriptions almost invariably tally. Our observations on the chiasmal region correspond with observations elsewhere in the brain. The arachnoid that forms the wall of the cisterna chiasmatis is thickened, grayish and opalescent instead of transparent and tough; in three of the four cases it was markedly distended with fluid. There may be a mass of adhesions, in which the arachnoid is involved, which lie between the dura over the anterior border of the sella and the chiasm, fixing the latter structure more or less to the base of the skull. Adhesions may also surround the optic nerves from the chiasm to the optic foramina, these adhesions spreading out fanwise to be attached to the basilar dura. The adhesions surround the optic nerves in the same fashion as they do the spinal cord or spinal nerves in spinal arachnoiditis. In the cases that we have seen at operation, the adhesions could be picked up with forceps and stripped off the optic nerve without damage to the latter. Microscopic sections of the wall of the cisterna chiasmatis and of the adhesions about the optic nerves unfortunately were not made, but there is no reason to suspect that sections would have disclosed anything different from the appearances described by other writers in connection with other parts of the brain. The sections from the area over the motor strip in case 4 showed meningo-encephalitis.

While this was the local pathologic condition about the optic chiasm in the four cases reported, it should be emphasized that it was only a part of a more or less generalized process distributed elsewhere over the brain. The particular approach that we use in the exposure of the chiasmal region enables us to see, on the side on which the operation is performed, the frontal and temporal lobes and the parietal region, including the motor strip; in all four cases the process involved the meninges, and in one case the cortex also, of the regions exposed. It has been our experience generally that chronic arachnoiditis is a fairly widespread disease regardless of the fact that the local symptoms produced by it may be referred to the cerebellum, the motor cortex, the chiasmal region or a certain level of the spinal cord; in other words, localized arachnoiditis is, in our experience, identified by symptomatology rather than by pathology.

In reviewing the symptoms and clinical signs of the four cases reported, it is clear that chronic arachnoiditis must be included among the pathologic conditions that produce symptoms referable to the optic chiasm and nerves and that are considered surgical from the standpoint of treatment. They include the primary pituitary tumors (adenomas) and cysts (adenomatous or derived from Rathke's pouch), the suprasellar cysts (derived from Rathke's pouch); the suprasellar adenomas, the suprasellar and parasellar meningiomas, the gliomas of the infundibulum, the primary gliomas of the optic chiasm and nerves, the occasional aneurysms, etc. Chronic arachnoiditis differs from the primary pituitary tumors in that it fails to expand or destroy the sella turcica and in this respect resembles many of the suprasellar lesions enumerated. Thus far in our experience it has not caused typical bitemporal hemianopia. The accompanying illustrations show that the more marked constriction of the fields occurred in the temporal region, but in our experience a more or less concentric constriction of the fields of vision has been the more characteristic observation. This is not true of the other lesions enumerated. It may be associated with symptoms of Fröhlich's disease, as in case 4. Historically, a difference noted between chronic arachnoiditis involving the chiasm and the conditions enumerated is the rapidity with which vision may be lost. In one of our cases loss of vision progressed to complete blindness in two weeks, in one case vision was almost lost in a few weeks, in one case in two months and in the fourth case in five months. In tumors about the chiasm loss of vision is usually more gradual. While these differences in symptomatology and physical signs are not striking or sufficient, perhaps, to enable one to make a positive diagnosis, they may serve as an aid in differentiating between this condition and the more common suprasellar lesions.

The operative treatment in this small series of cases consisted in the evacuation of the distended cisterna chiasmatis, followed by the excision of its presenting wall so far as possible, and the freeing of the optic chiasm and nerves from their enveloping adhesions, usually by blunt, but occasionally by sharp, dissection. A search was made in each case for a tumor or other pathologic condition about the optic chiasm, but nothing abnormal was found, aside from the chronic arachnoiditis. In each case we were prepared to find this condition about the optic chiasm, for it was obvious over the hemisphere as soon as we had reflected the dural flap. The operation is far simpler than that of the removal of a tumor, for there is not, and should not be, any hemorrhage.

The results of the operative treatment in these four cases have been satisfactory. There were no postoperative complications and no immediate mortality. Vision improved before the patients left the hospital and continued to improve, so that at periods of three years, one year, eleven months and one and a half months after operation all four patients were able to read ordinary print and do their usual work.

TWO PER CENT EPINEPHRINE SOLUTIONS AS SUBSTITUTES FOR LAEVOGLAUCOSAN *

JOHN GREEN, M.D.
ST. LOUIS

Many are familiar with the properties of the synthetic levorotatory tartaric acid alkaloid derived from the suprarenal capsule, the so-called links or laevoglaucosan that was introduced by Hamburger in 1923. Used in 2 per cent solution and combined with methylamino-acetopyrocatechol in the same strength, it can be used by instillation and produces the following effects: (1) intense ischemia of the conjunctiva, with bloodless islets appearing in the cheek, lid and temple; (2) widening of the palpebral aperture; (3) regular and wide dilatation of the pupil, and (4) a diminution in intra-ocular tension (sometimes preceded by an initial rise).

I have used laevoglaucosan in cases of glaucoma simplex for three years, and believe it to be a valuable adjuvant to miotics. It is not universally successful in reducing tension; some failures must be admitted.

Laevoglaucosan has the following drawbacks: (1) it is furnished in small ampules, each containing only a few minims of the solution; (2) unless great care is taken, it is almost impossible to gain access to the solution without spilling one or two drops; (3) as a mydriatic it has the disadvantage of causing a whitish granular deposit on the cornea, thus veiling and distorting the ophthalmoscopic picture; (4) its price, in this country at least, is prohibitive for all but well-to-do patients. (As with all medicinal agents in glaucoma, its use must be continuous to be effective.)

For over a year I have been endeavoring to interest American pharmaceutical houses in the preparation of stronger solutions of epinephrine. In response to my original plea, Parke, Davis & Company furnished several small bottles of 1:500 and 1:100 solutions of adrenalin chloride. The 1 per cent solution proved of advantage as a mydriatic in cases of uveitis with increased tension, but was not as effective as laevoglaucosan in reducing tension in glaucomatous eyes. Finally, explicit directions were furnished for making a 2 per cent solution of adrenalin chloride from adrenalin substance. This was made by my druggist for use in the office, and in some cases I entrusted it to patients for use at home.

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* Submitted for publication, Sept. 16, 1930.

* Read before the American Ophthalmological Society, Hot Springs, Va., June 3, 1930.

Recently about 2 ounces (56.7 Gm.) of 2 per cent adrenalin chloride was sent to me by the manufacturers. It is said to be entirely free from by-products and is levorotatory. If a demand occurs for the product in this strength, it can be marketed in 0.5 or 1 cc. ampules, so that a fresh ampule can be used for each treatment.

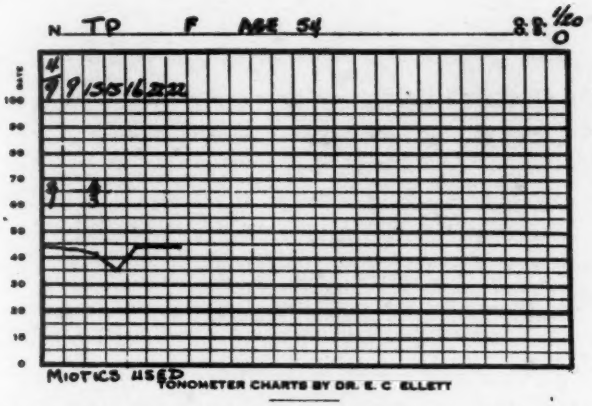

Chart 1.—Advanced glaucoma simplex of right eye. Left eye, soft blind eye following chronic iridocyclitis. April 9, 1930: right eye, tension 45 (Schiötz); slight drop following a single instillation of suprarenin 2 per cent. April 15: right eye, tension 42 (Schiötz), followed by drop to 35 following three instillations of adrenalin chloride 2 per cent. April 16: right eye, tension 44. April 22: right eye, tension 44. Operation advised.

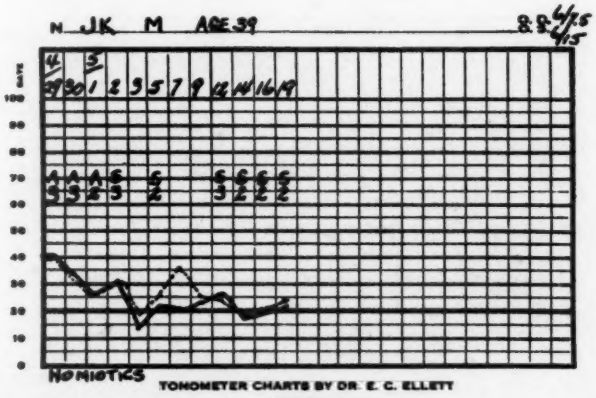

Chart 2.—Glaucoma simplex of both eyes, moderate cupping and slight peripheral contraction. Tension of the right and of the left eye was 40. There was a decided drop after instillations of adrenalin. Tension was maintained at 23 or below following instillations of suprarenin. Miotics were not used.

The H. A. Metz Laboratories, Inc., has furnished me with several ounces of 2 per cent suprarenin bitartrate. This is the levorotatory bitartrate of levorotatory synthetic epinephrine. In the process of manu-

facture, methylamino-acetopyrocatechol is produced as one of the intermediate products from which suprarenin is synthesized. The product can be marketed either as a 2 per cent solution (in ampules) or in powder form (in hermetically sealed tubes) for immediate solution in distilled water (thus affording a fresh solution for each treatment).

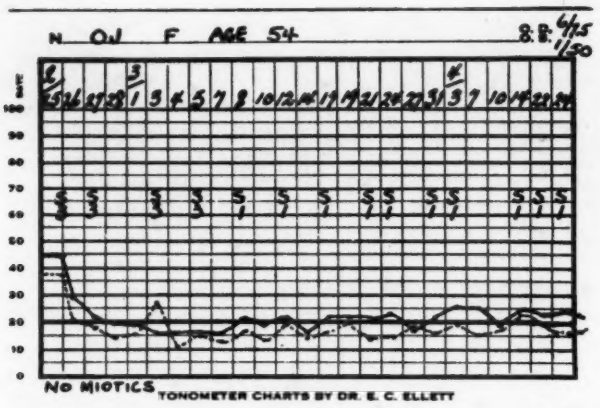

Chart 3.—Glaucoma simplex (early) of right eye; glaucoma simplex (advanced) of left eye. The tension dropped from 45 and 38 to less than 20 in the better eye after the instillation of suprarenin 2 per cent. After two weeks, the tension was maintained at this point by a single instillation of suprarenin at three and four day intervals.

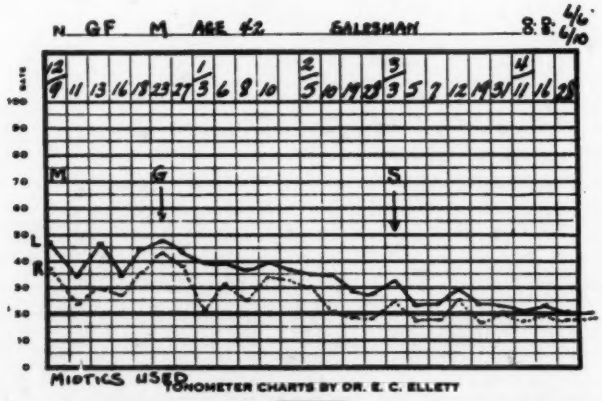

Chart 4.—Glaucoma simplex in both eyes, moderately advanced. Tension in the right eye was 38; that in the left eye, 47. Miotics were used without much effect on tension. The use of laevoglaucosan was much more effective, but the tension still remained above 20. The instillation of suprarenin bitartrate eventually reduced the tension to slightly above 20 in the left eye and slightly below 20 in the right eye.

Clinical investigations with the foregoing solutions are now being carried on, and the results will be published at a later date. In about fifteen cases so far studied the following effects were produced: (1)

mydriasis of varying degrees, most marked in glaucomatous eyes; (2) ischemia of the conjunctiva, but no extension of the ischemia to the skin, and (3) lowering of the tension in glaucomatous eyes (this was the rule, but there were exceptions).

As with glaucosan, a slight roughening of the corneal epithelium occurs after several instillations. I have observed no white granular deposits. There has been a complete absence of systemic effects. There is some burning pain immediately following instillation, but this passes off in less than a minute. It may be desirable, in sensitive patients, to precede the instillation by a few drops of holocaine.

For the benefit of those who may prefer to prepare fresh 2 per cent solutions of adrenalin chloride and suprarenin bitartrate, the following directions are appended:

Adrenalin Chloride: Thoroughly cleanse amber bottle and glass stopper. Immerse five minutes in hydrochloric acid (chemically pure); rinse bottle and stopper and boil five minutes in distilled water. Prepare a 5 per cent solution of hydrochloric acid (chemically pure); add 1 grain (0.065 Gm.) of adrenalin substance to 3 cc. of distilled water to which 10 drops of the 5 per cent hydrochloric acid solution has been added.

Suprarenin Bitartrate: Dissolve 90 mg. of suprarenin bitartrate in 2.5 cc. of distilled water.

CHEMICAL STUDIES OF LIPIDS OF NORMAL ANIMAL LENSES, CATARACTOUS HUMAN LENSES AND THE BLOOD OF PATIENTS WITH CATARACT *

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On examining the literature on senile cataract, one is particularly impressed by the fact that so many investigators have, in one way or another, obtained evidence of large increases in lipids in cataractous lenses. Cholesterol, evidently on account of the ease with which it can be identified by its characteristic crystalline structure, has been most frequently pointed out in this connection among other lipid fractions. Von Graefe [1] probably was the first to publish a report of his discovery of the presence of cholesterol in both lenses of a woman aged 73. Later Mettenheimer [2] discovered doubly refractile substances in cataractous lenses which could not be found in normal lenses. He regarded them as myelin. In one particular case in which the lens presented a rather clear appearance he also succeeded in isolating cholesterol in addition to myelin, by boiling with alcohol. About twenty-seven years after the publication of von Graefe's report, the first systematic study of the chemical composition of both normal and cataractous lenses was carried out by Cahn.[3] Since then numerous investigators have confirmed Cahn's observations. Lang,[4] Krautschneider,[5] Toufesco,[6] Leber,[7] Gross,[8] Hoffmann,[9] Adam,[10] Vogt,[11] Wessely [12] and Busacca [13]

* Submitted for publication, Sept. 30, 1930.

* From the Departments of Ophthalmology and Biochemistry, State University of Iowa.

1. von Graefe: Arch. f. Ophth. **1**:323, 1854.
2. Mettenheimer, quoted by Kranz, H. W.: Arch. f. Ophth. **118**:571, 1927.
3. Cahn: Hoppe-Seylers Ztschr. f. physiol. Chem. **5**:213, 1881.
4. Lang: Tr. Ophth. Soc. U. Kingdom **15**:117 and 118 (Nov.) 1895; quoted by Kranz, H. W.: Arch. f. Ophth. **118**:571, 1927.
5. Krautschneider: Beitr. z. Augenh. **26**:34, 1897; quoted by Kranz, H. W.: Arch. f. Ophth. **118**:571, 1927.
6. Toufesco, S.: Ann. d'ocul. **136**:1015, 1906; quoted by Kranz, H. W.: Arch. f. Ophth. **118**:571, 1927.
7. Leber: Arch. f. Ophth. **62**:85, 1906.
8. Gross: Arch. f. Augenh. **57**:107, 1906.
9. Hoffmann: München. med. Wchnschr. **60**:741, 1913.
10. Adam: Verhandl. d. Berlin. Ophth. Gesellsch. **23**:1, 1913.
11. Vogt, A.: Klin. Monatsbl. f. Augenh. **63**:232, 1919.
12. Wessely: Arch. f. Augenh. **91**:158, 1922.
13. Busacca: Rev. gén. d'opht. **39**:439, 1925.

have observed crystalline masses in the lenses of some of their patients. In their physical properties, as revealed by the slit-lamp or the polarization microscope, the crystals in most cases resembled those of cholesterol or myelin. In some cases, when the lens was removed and the crystals were subjected to a more minute examination, they invariably responded to tests for lipids, especially cholesterol. In a few cases the crystals were found scattered through an otherwise clear lens, but most frequently they occurred in association with opacities and especially with mature cataracts. The most recent, extensive and thorough microscopic examination of cataractous lenses has been carried out by Kranz,[14] who used the polarization microscope. Myelin-like, doubly refractile substances and occasionally cholesterol crystals were found only in senile cataracts and in traumatic cataracts caused by some gross physical injury. They were not present in traumatic cataracts caused by perforation, in swollen lamellar cataracts or in clear normal lenses.

Evidences for increases in lecithin in cataractous lenses are less numerous. However, those that are available show unmistakably that an increase in lecithin may be only second in importance to the increase in cholesterol. Thus Cahn [8] called attention to the fact that the cholesterol content of cataractous lenses runs from 4.55 to 6.22 per cent (on the basis of dry lens substance), whereas the values for lecithin vary between 0.80 and 4.52 per cent. For the normal human lens the values for cholesterol and lecithin, as given by Cahn, are 0.62 and 0.63 per cent, respectively (likewise computed on the basis of dry lens substance). One might ask: Are these increases in lipids the consequence of certain pathologic conditions, or are they the natural manifestations of old age? Bürger and Schlomka [15] determined the cholesterol content in the normal lenses of cattle varying in age from 1 day to 17 years. They found that this lipid fraction increased from an average of 56 mg. per hundred grams in cattle of from 1 day to 1 year to an average of 222 mg. per hundred grams in cattle of from 14 to 17 years. A diligent search, however, has failed so far to reveal any such work carried out on lecithin. Analyses of cattle lenses between the ages of 5 weeks and 2 years along with the analyses of cataractous human lenses were therefore carried out for both cholesterol and lecithin.

METHOD OF ANALYSIS

Cholesterol and lecithin were determined on normal animal lenses, cataractous human lenses and the blood of patients with cataract, which was usually drawn just before the midday meal. Cholesterol alone was determined on normal human

14. Kranz, H. W.: Arch. f. Ophth. **118**:571, 1927.

15. Bürger, M., and Schlomka, G.: Ztschr. f. d. ges. exper. Med. **58**:710, 1927.

TABLE 1.—*Values of Cholesterol and Lecithin from Lenses of Cattle of Various Ages*

Animal	Age of Animal	Number of Eye	Weight of Fresh Lens, Gm.*	Cholesterol, Mg. per 100 Gm.	Lecithin, Mg. per 100 Gm.
1	5 weeks	1	0.9822	50.1	.....
		2	0.9871	....	119.0
2	1½ years	1	2.0302	40.8	111.5
		2	2.1584	41.8	104.3
3	1½ years	1	1.7445	40.0	123.8
		2	1.6627	47.0	118.4
4	1½ years	1	1.9936	40.7	106.0
		2	2.0058	43.7	111.0
5	1½ years	1	2.3081	54.4	110.0
		2	2.1734	53.6	118.5
6	1½ years	1	2.0106	55.4	137.5
		2	2.0818	42.5	105.6
7	1½ years	1	1.8240	35.6	86.2
		2	1.8371	31.3	95.7
8	1½ years	1	2.2116	42.1	108.3
		2	2.1317	40.0	96.4
9	1½ years	1	2.2081	40.6	90.7
10	1½ years	1	1.8464	40.0	106.6
		2	1.8509	40.3	112.9
11	2 years	1	2.2470	44.8	.....
12	2 years	1	2.2500	45.6	.....
		2	2.1851	47.1	.....
13	2 years	1	2.1592	55.6	124.3
		2	2.0663	52.8	120.0
14	2 years	1	2.4892	60.2	132.5
		2	2.4349	60.6	96.5
15	2 years	1	1.9927	....	103.2
16	2 years	1	2.3089	60.4	95.2
		2	2.3068	63.4	115.0
17	2 years	1	1.7634	49.7	106.5
18	2 years	1	2.0733	42.2	108.0
		2	2.0637	35.5	105.3
19	2 years	1	2.1475	37.2	106.7
		2	2.1463	....	109.5
20	2 years	1	2.1313	40.6	111.6
		2	2.1310	34.3	106.0
21	2 years	1	2.1680	41.0	118.0
		2	2.2303	35.2	102.7
22	2 years	1	1.9579	46.4	108.0
		2	1.8773	....	111.2
23	2 years	1	1.8172	40.0	107.7
		2	1.6445	35.1	108.8
24	2 years	1	1.8588	38.0	109.3
		2	1.8187	38.0	114.8
25	2 years	1	2.1976	38.2	114.0
		2	2.1036	34.9	99.1
26	2 years	1	1.7343	32.3	104.7
		2	1.7980	36.8	111.8
27	2 years	1	1.6670	35.0	105.1
		2	1.7753	37.7	113.8
28	2 years	1	1.8032	36.4	117.2
Rabbit	Adult	1	0.5698	51.0	.....
		2	0.5776	....	130.9

* Both the cholesterol and the lecithin were determined on the same lens (except for the 5 weeks old calf and the rabbit), the ether-alcohol extract of the lens being equally divided between the two determinations.

lenses. In the estimation of cholesterol, Bloor's [16] colorimetric method was used, with slight modifications. For lecithin, Whitehorn's [17] colorimetric method proved to be the best.

Saponifiable fat was determined on both the cataractous lenses and the blood of patients with cataract by the nephelometric method of Bloor.[16]

Determinations of sugar were made only on the blood of patients with cataracts. Benedict's [18] colorimetric method was used.

ANALYSIS OF ANIMAL MATERIAL

In table 1 are given the values for cholesterol and lecithin obtained on fresh lenses of cattle of various ages.

In table 2 are given average values for cholesterol and lecithin of fresh lenses for different age groups of cattle, and for one rabbit. The slight differences in the figures, if not attributable to experimental error, seem to corroborate the expectation of a certain parallelism between cholesterol and lecithin.

TABLE 2.—*Average Values for Cholesterol and Lecithin of Fresh Lenses from Cattle and for One Rabbit*

	Cattle			Rabbit
Age or weight of animal.....	5 weeks	1½ years	2 years	5 pounds
Cholesterol, mg. per 100 Gm.....	50.1 (1)*	42.9 (17)	43.3 (29)	51 (1)
Lecithin, mg. per 100 Gm.....	119.0 (1)	108.5 (17)	110.0 (29)	130.9 (1)

* The figures in parentheses denote the number of lenses on which the averages (above them) were based.

The differences in the determinations of both cholesterol and lecithin, as seen from table 1, are entirely within individual variations among animals of the same age. The average figures for cholesterol (table 2), however, agree with those obtained by Bürger and Schlomka for animals of the same age. From an examination of the figures given by those authors, it appears that the rate of increase in the lipids in cattle is greatest between the ages of 8 and 15 years.

ANALYSES OF CATARACTOUS HUMAN LENSES AND THE BLOOD OF PATIENTS WITH CATARACT

In view of the prominent place that cholesterol and lecithin occupy in the literature on cataract, increased importance is attached to the suggested accumulation of these substances in the cataractous lens.

In table 3 are listed the case histories (abbreviated) and the analytic data for lipids obtained from twenty-nine cases of cataractous lenses,

16. Bloor: J. Biol. Chem. **17**:370, 1914.
17. Whitehorn, J. C.: J. Biol. Chem. **62**:133, 1924.
18. Benedict, S. R.: J. Biol. Chem. **68**:759, 1926.

TABLE 3.—*Case Histories and Analytic Data for Lipids Obtained from Twenty-Nine Cases of Cataractous Lenses*

	Sex, Age, Vision, History	Weight of Lens, Mg.	Cholesterol, per Cent	Lecithin, per Cent	Saponifiable Fat, per Cent	Sugar, Mg. per 100 Gm.
1.	Male; aged 64; vision in the right eye, 6/60; that in the left eye, 4/60; failing vision for four years; kidney trouble	82	0.60	....	1.53	...
		Blood	0.22	0.33	0.66	119
2.	Male; aged 37; vision in the right eye was reduced to counting fingers at 15 cm.; that in the left eye, to counting fingers at 2 meters; right eye failing for five years; left eye, 2 years; pyorrhea, chronic tonsillitis, ethmoiditis	108	0.51	....	4.00	...
		Blood	0.19	....	0.49	...
3.	Male; aged 79; failing vision for twelve years; unable to get about for three years; typhoid fever	162	0.70	....	....	...
		Blood	0.21	....	0.81	105
4.	Female; aged 78; vision in right eye, 6/30; that in left eye, light projection; right eye failing for one year; left eye, three years; diabetes and rheumatism	158	0.51	....	....	...
		Blood	0.17	....	0.69	127
5.	Male; aged 66; vision in right eye, 3/60; left eye, light projection; right eye failing vision for three years; left eye blind for five years; father had cataracts; influenza; edentulous	137	0.70	....	3.29	...
		Blood	0.16	0.30	0.52	129
6.	Male; aged 70; vision in right eye, 3/60; left eye, light projection; right eye failing for six months; left eye one and a half years; influenza with pneumonia; dental caries, teeth extracted	128	0.71	....	....	...
		Blood	0.17	0.34	0.53	133
7.	Male; aged 66; unable to get about for six months; right eye aphakic; left eye failing for five years; infected teeth extracted	153	0.89	....	2.31	...
		Blood	0.18	0.37	0.51	112
8.	Male; aged 74; vision in right eye, 6/30 + 1; left eye, light projection; diffuse opacities of both lenses	185	0.63	....	2.73	...
		Blood	0.16	0.31	1.06	107
9.	Female; aged 68; eyes failing for three years; light perception only now; typhoid fever; edentulous	151	0.57	....	3.00	...
		Blood	0.17	0.31	0.77	93
10.	Female; aged 52; vision in right eye limited to light and shadow for three and a half years; left eye failing for two months	178	0.23	0.48	....	...
		Blood	0.13	0.28	0.71	136
11.	Female; aged 71; left eye failing for two years; right eye less affected; unable to read; typhoid fever; hay-fever each August; edentulous	138	0.73	0.94	....	...
		Blood	....	0.22	0.91	115
12.	Male; aged 72; right eye failing for four years, left eye for 2 years; unable to read for past eight months; typhoid fever; edentulous	186	0.57	0.65	....	...
		Blood	0.15	0.26	0.50	117
13.	Male; aged 72; left eye failing for one and a half years, right eye one month later; unable to read past three months; typhoid fever; poor teeth	176	....	0.71	....	...
		Blood	0.14	0.33	0.72	88
14.	Female (colored); aged 73; failing vision for three years; poor vision now; edentulous	128	....	0.89	....	...
		169	0.72	1.25	....	...
		Blood	0.17	0.34	1.00	93
15.	Female; aged 72; both eyes, light projection; right eye blind first; edentulous	90	0.76	1.26	....	...
		Blood	0.18	0.32	0.86	107
16.	Female; aged 75; both eyes, light projection for one year	109	0.78	1.06	....	...
		138	0.39	0.28	....	...
		Blood	0.13	0.31	0.97	101
17.	Male; aged 64; vision in right eye, light projection; vision in left eye, 3.5/60; in right eye mature cataract; in left eye, immature cataract; remaining teeth extracted	115	0.70	1.17	....	...
		Blood	0.15	0.41	0.61	94
18.	Female; aged 49; vision in right eye failing for seven years, that in left eye failing for five years	98	....	0.94	....	...
		117	....	0.68	....	...
		Blood	0.14	....	0.61	97
19.	Female; aged 55; vision in right eye, 1/60; that in left eye, light projection; right eye failing for one year, left eye, two years; typhoid fever three times, malaria, sinus infection	131	0.65	0.69	....	...
		106	0.63	....	4.06	...
		Blood	0.17	0.34	0.66	117
20.	Male; aged 68; poor vision all his life; intermittent fever at age of 38; operation for ruptured appendix; nocturia one to four times	148	0.56	1.38	....	...
		Blood	0.17	0.30	0.63	88

TABLE 3.—*Case Histories and Analytic Data for Lipids Obtained from Twenty-Nine Cases of Cataractous Lenses.—Continued*

	Sex, Age, Vision, History	Weight of Lens, Mg.	Cholesterol, per Cent	Lecithin, per Cent	Saponifiable Fat, per Cent	Sugar, Mg. per 100 Gm.
21.	Male; aged 53; right eye failing for four years, left eye, one year; rheumatism five years ago, mother had cataracts in both eyes	119	0.68	1.88	....	...
		Blood	0.19	0.31	0.65	104
22.	Male; aged 54; right eye failing for five years, left eye, two years; gets about fairly well; incipient diabetes years ago; edentulous	175	0.61	1.44	....	...
		Blood	0.18	0.30	0.91	105
23.	Female; aged 68; incipient cataract in both eyes; able to read; frequency for several years; one tooth extracted	132	0.79	1.49	....	...
		Blood	0.18	0.31	0.85	82
24.	Male; aged 59; vision in right eye failing for four months; thirty years ago small piece of iron struck right eye; ptomaine poisoning ten years ago	110	....	0.76	....	...
		Blood	0.17	0.31	0.80	110
25.	Male; aged 73; right eye failing for one year, left eye from ten to eleven years; vision in both eyes, perception of light and shadow only; one molar extracted	135	....	0.84	....	...
		156	0.63	....	....	...
		Blood	0.14	0.27	0.38	101
26.	Male; aged 74; right eye failing for twenty years, left eye from three to four years; unable to get about; Wassermann reaction, 4+	139	....	0.63	....	...
		Blood	0.20	0.31	0.83	136
27.	Male; aged 74; right eye failing for four years, left eye, nine years; polyopia; infected teeth extracted	159	0.65	....	....	...
		Blood	0.13	0.33	0.59	122
28.	Male; aged 74; failing vision for two years; unable to read for the past year; rheumatism several years ago	167	0.63	....	....	...
		Blood	0.14	0.30	0.44	87
29.	Female; aged 74; both eyes, light projection; failing vision for one year	120	Whole lens for lecithin	0.49	....	...
		Blood	0.14	0.29	0.42	130

together with the figures on the cholesterol, lecithin and sugar in the blood of the same patients.

In table 4, the data on lens lipids are arranged in order of age of the patients. The corresponding durations of the cataract are given for both eyes.

From the data presented in table 4 it is seen that of the twenty-nine patients, fifteen were between the ages of 70 and 80 years, seven between 60 and 70, five between 50 and 60, one between 40 and 50 and one below 40. A survey of the values for lipid in relation to the ages of the patients seems to indicate that once the cataract has established itself in the lens, the lipid content of the lens is in no way dependent on the age of the patient. Furthermore, the amount of lipids in the cataractous lens seems to give little, if any, information as to the duration of the cataractous condition. It must, however, be considered that a case history as conceived and told by the patient at a moment's notice, as it were, is not always in conformity with facts. But the data seem to indicate at least that cataractous symptoms, which usually appear within from one to two years after the patient has noticed the first signs of failing vision, are not coextensive with the process of accumulation of the lipids. The latter, which must be a slow process, evidently precedes the loss of vision by many years.

In table 5 are listed the average values of all the lipids determined on cataractous lenses with ranges of variations.

Two normal lenses obtained at autopsy from a 2 year old child and an adult gave 0.182 and 0.174 per cent cholesterol, respectively.

A third lens, which was obtained from the eye of an adult following an accident, contained 0.275 per cent of cholesterol. These values are four or five times as high as those for beef lenses, and equal the figures usually obtained on the blood of patients with cataract.

Values for cholesterol of the blood of the foregoing patients with cataract, as summarized in table 6, seem to have no association with the age of the patient. However, all values except the one for the

TABLE 4.—*Data on Lens Lipids, with Duration of Cataract*

Series Number*	Age	Approximate Duration of Cataract, Years	Cholesterol, per Cent	Lecithin, per Cent	Saponifiable Fat, per Cent
2	37	2, 5	0.51	....	4.00
18	49	5, 7	....	0.68, 0.94	....
10	52	⅛, 3½	0.23	0.48	....
21	53	1, 4	0.68	1.88	....
22	54	2, 5	0.61	1.44	....
19	55	1, 2	0.65, 0.63	0.69	....
24	59	⅛	....	0.76	....
1	64	4	0.60	1.53	1.53
17	64	?	0.70	1.17	....
7	66	1, 5	0.89	....	2.31
5	66	3, 5	0.70	....	3.29
9	68	3	0.57	....	3.00
23	68	5	0.79	1.49	....
20	68	?	0.56	1.38	....
6	70	½, 1½	0.71	....	2.76
11	71	2	0.73	0.94	....
12	72	2, 4	0.57	0.65	....
13	72	¼, 1½	....	0.71	....
15	72	?	0.76	1.26	....
25	72	1, 11	0.63	0.84	....
14	73	1	0.72	0.89, 1.25	....
4	73	1, 3	0.51	....	....
8	74	¼	0.63	....	2.73
26	74	3, 20	....	0.63	....
27	74	4, 9	0.65	....	....
28	74	2	0.63	....	....
29	74	1	....	0.49	....
16	75	1	0.78, 0.39	....	....
3	79	12	0.70	....	....

* See table 3.

TABLE 5.—*Average Values of All Lipids Determined on Cataractous Lenses*

	Cholesterol	Lecithin	Saponifiable Fat
Average percentage	0.61	0.99	2.80
Range, percentage	0.23-0.89	0.48-1.88	1.53-4.00
Number of lenses	26	20	7

age 49 are in the upper normal range of from 0.14 to 0.17 per cent, or slightly above.

Values for blood lecithin for all patients are more or less normal and center closely around the upper limit of the normal value of 0.3 per cent.

Probably not much importance should be attached to the rather wide fluctuations in the values of saponifiable fat of the blood of the patients, considering the fact that no control of the patient's activity and diet was attempted.

Values for sugar, which were determined on the venous blood, are within normal limits, except for the blood from a syphilitic patient and blood from a few diabetic patients.

COMMENT

As shown by the results of the experiments and the observations of other investigators, the lipid content of senile human cataracts is abnormally high. There is also some indication that the blood cholesterol of patients with cataract is slightly above normal. This is in accordance with the observations of O'Brien and Myers,[19] who examined the blood of fifty-four patients with cataract and found the cholesterol value in 54 per cent of the cases somewhat above normal. Michail and Vancea [20] produced hypercholesterolemia in rabbits by feeding them naphthalene. They ascribed this condition to the reaction of the organism in combating the naphthalene poisoning. It is possible that the accumulation of lipids in cataractous lenses is the consequence of a similar physiologic reaction toward certain poisons in the blood.

TABLE 6.—*Average Values for Blood Cholesterol in Patients with Cataract Grouped in Decades*

Age	37	49	50-60	60-70	70-80
Cholesterol, per cent	0.19	0.14	0.17	0.18	0.16
Number of cases	1	1	5	7	15

SUMMARY

1. The forty-six determinations for cholesterol of lenses of cattle of from 1½ to 2 years gave an average of 43 mg. per hundred grams. The cholesterol content of a lens from a 5 week old calf was found to be 50.1 mg. A lens of a rabbit's eye contained 51 mg. of cholesterol. The lecithin values are represented by the same lenses as follows: 110 mg. per hundred grams for cattle of from 1½ to 2 years, 119 mg. for the calf of 5 weeks and 131 mg. for the rabbit.

2. The results of analyses for lipids of cataractous lenses are as follows: twenty-six determinations on cholesterol, average 0.61 per cent ranging from 0.23 to 0.89 (for normal human lenses, three determinations, average 0.21 per cent ranging from 0.17 to 0.28); twenty determinations on lecithin average 0.99 per cent, ranging from 0.48 to 1.88; seven determinations on saponifiable fat, average 2.80 per cent, ranging from 1.53 to 4.

19. O'Brien, C. S., and Myers, V. C.: Chemical Analyses of Blood in Patients Having Senile Cataract, Arch. Int. Med. **42**:376 (Sept.) 1928.

20. Michail, D., and Vancea, P.: Compt. rend. Soc. de biol. **97**:1569, 1927.

WEAKNESS OF ACCOMMODATION*

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All that is known about the clinical features and pathology of accommodation rests on Helmholtz' explanation of the physiologic mechanism, and any abnormality encountered can really be explained by this theory. It is true that one is still unable mechanically or physically to record the function of the ciliary muscle and the change of the curvature of the crystalline lens proper to accommodation, but the physico-optical observations and physiologic conclusions do not permit refutation of the theory that Helmholtz set up so objectively. According to this theory, the increase of the refractive power of the lens, due to the increase in the convexity of the anterior surface of the lens so that the images of near objects may form on the retina during accommodation, is produced by contraction of the ciliary muscle and relaxation of the zonule. This old theory, ingeniously erected and thus far unshaken, gives a plausible explanation of the position occupied by the lens at rest and the function of the ciliary muscle. The traction of the tightened zonular fibers keeps the lens flattened. By the contraction of the ciliary muscle of Mueller-Bruecke, anteriorly inserted on the sclera near Schlemm's canal, the zonular fibers undergo relaxation; the lens is thus enabled to increase in convexity by a change in the radius of its curvature in conformity to the physiologic condition of its elasticity. The concomitant reduction of the reflected image on the anterior surface of the lens, a slight lowering of the whole of the lens, and its vibrations can sometimes also be observed by the physiologico-optical method.

The great majority of ophthalmologists consider that the modern theories concerning the process of accommodation in man fall short of explaining accommodation.

The theory of Helmholtz alone explains the many paralyses and pareses of accommodation frequently met with in clinical pathology. Setting aside deficiency in accommodation due to alterations of the lens, such as sclerosis of the lens tissue in presbyopia or change of the refractive index due to colloido-osmotic disturbances in diabetes, it is easily seen that the whole pathology of accommodation consists not only of direct, but for the most part of indirect alteration of the function of the ciliary muscle, and that all the total or partial paralyses of accommodation are linked to the centrally or locally decreased function of this muscle.

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Paralysis or paresis of accommodation is present when there is either complete absence or insufficiency of the act of accommodation, i.e., when the amplitude of accommodation is zero or is decreased, the near point lying at a distance exceeding that empirically established as the physiologic correlate of the eye observed. In the pathology of accommodation, however, one must become better acquainted with a third conception, namely, that of weakness of accommodation. This will enable one to refine the technic of accommodation tests, which sometimes prove a secure aid in the diagnosis of inexplicable ocular pain or of diseases of the central nervous system.

It has become customary to consider as pareses of accommodation conditions in which the near point is at a distance exceeding that which corresponds to the age of the patient, and to attribute them to a paralysis of the ciliary muscle. Of course, any manifest paresis of accommodation can be proved to be due in some degree, to paresis of the ciliary muscle. Not every paresis of the ciliary muscle, however, produces a manifest paresis of accommodation, as Willbrand and Saenger have stated; at least it would not always be possible in my opinion to find out the nature of the paresis with the routine technic of the accommodation tests hitherto in use. The question arises, however, as to whether these so-called latent pareses of the ciliary muscle, or rather these impairments of the power of the ciliary muscle, must remain masked. In a patient with asthenopia and inability to do close work for a considerable time—the objective ocular observations otherwise being normal—if one is content with showing that the near point lies at a normal distance, the resulting gap in the diagnosis will prevent one from ascertaining the cause of the asthenopic disorder of accommodation. In some cases, however, in which the near point is found at a normal distance on the first examination, several successive tests at intervals of from three to five minutes will disclose the near point at a constantly greater distance, showing the presence of weakness of accommodation. Why can a patient with weakness of the ciliary muscle show the near point for normal distance, provided his eyes are rested, and why does the near point in a case of weakness of accommodation recede further and further on repeated tests? Why does the patient easily tire when performing close work for any length of time? Even when accommodation is normal one does not avail oneself of the maximum of dynamic refraction, since part of the power of the ciliary muscle remains unused. When there is weakness of accommodation, this reserve power is lacking for some reason; asthenopia in conjunction with marked fatigue ensues. This corresponds with Landolt's [1] statement that in close work at least one third of the

1. Landolt, E.: Die Untersuchungsmethoden, in Graefe-Saemisch Handbuch der gesamter Augenheilkunde, ed. 2, Leipzig, W. Engelmann, 1904, vol. 4, pt. 1.

accommodation is kept in reserve and only two thirds are utilized. When the function of the ciliary muscle is normal, that is, when accommodation is in order, maximal contraction of the ciliary muscle can be put forth, if necessary, with the aid of the reserve power; when there is weakness of accommodation, however, though the acuity of vision many remain normal for near vision and the near point can be brought to normal distance, this can be done only by the greatest strain on the reserve power of the ciliary muscle. It may seem, therefore, that there are only indistinct differences between paresis and weakness of accommodation. This is not true, however, because the etiology, course, association with other ocular lesions and deficiencies in various functions of the physiologic activity of the ciliary muscle permit of defining a distinct borderline between paresis and weakness of accommodation. Paresis of accommodation entails a loss in the manifest part of the amplitude of accommodation; weakness of accommodation does so in its latent part. In weakness of accommodation recession of the near point follows only fatigue of the eye; in paresis of accommodation, however, it is present even after rest.

As regards the clinical form, course, and clinical symptoms of weakness of accommodation, many valuable general features can be shown with an improved technic of examination. The subjective troubles will appear as a rule, in the form of ready fatigability in near work, blurring and cloudiness of the types, ocular pain, headache and general malaise. The subjective symptoms are, no doubt, much more frequent and severe in weakness of accommodation than they are in paresis of accommodation though at bottom they are of the same kind in both conditions. These subjective symptoms are lacking in impairment of physical accommodation (presbyopia). The complex of the aforesaid subjective symptoms, which is also called accommodative asthenopia and is generally considered as a functional nervous sign of the disturbed act of accommodation, is found to appear best in weakness of accommodation. In this condition accommodative asthenopia adopts the most varied forms, from simple headache to the most severe picture of a migraine-like ocular neuralgia, and from slight photophobic manifestations to the alarming symptoms of scintillating scotoma.

FORMS OF WEAKNESS OF ACCOMMODATION

Examined objectively, weakness of accommodation may appear in two forms: 1. In the form already mentioned, the near point is found at a distance corresponding to the age of the patient, but several successive tests, at from three to five minute intervals, show that the near point recedes farther at each test. When the eyes are allowed to rest, from half an hour to an hour, and the near point is taken again, it is

found at the same distance as in the first test. At the first test in some cases of weakness of accommodation I have seen the near point somewhat farther off than corresponded to the age of the patient. These small degrees of abnormal distance of the near point, however, are not incompatible with the assumption that there is weakness of accommodation. In several systematically performed tests I have been able to establish that the distance of the near point has no constant value even in subjects with normal accommodation; there are slight oscillations dependent on the physiologically variable condition of the system. Thus I have found slight increases in the near point following emotional expression, too copious a dinner, excessive venery and several hours of mental work. I have found the distance of the near point to be greater in the morning than in the evening. These physiologic fluctuations of the distance of the near point show still higher values, of course, when there is weakness of accommodation.

2. A less frequent form of weakness of accommodation is that in which there is retardation of the act of accommodation alone or in conjunction with the former form. Though distance of the near point proves normal, accommodative fatigue may manifest itself by the near point moving farther off, as proved by repeated tests; it is striking to watch the retardation in the act of accommodation, the eye adjusting itself to its near point later and being able to read fine type at a distance of 25 to 30 cm. only after having exerted the effort of accommodation for a considerable length of time. The act of accommodation can thus develop only slowly; it takes longer than does normal accommodation to come to an end, i.e., to reach the height of its activity. In people with normal accommodation I have found the time of exertion of accommodation to average from two to six seconds, and that of relaxation from three to seventeen seconds. In this form of weakness of accommodation the time of exertion of accommodation is much longer.

The behavior of the pupillary reactions and the action of cocainization on the act of accommodation is so characteristic in various cases of weakness of accommodation as to become of pathognomonic importance. At times I have found the pupillary reaction to convergence to run a somewhat slower course in weakness of accommodation than does the reaction to light, because the impulse of convergence is too feeble to produce prompt miosis. Cocaine has a frankly paralyzing effect on the normal ciliary muscle. According to Flieringa's [2] communications, displacement of the near point occurred thirty-two minutes after cocainization. I have found this paralyzing action of cocaine enhanced in several cases of weakness of accommodation, the near point receding

2. Flieringa: Brit. J. Ophth. **8**:367, 1924. Flieringa and van der Hoeve: Arch. f. Ophth. **114**:1, 1924.

notably in a shorter time, and a complete paralysis of accommodation ensuing.

In weakness of accommodation there is a further deviation from normal conditions in regard to binocular accommodation. In normal accommodation the value of binocular accommodation is superior to that of monocular accommodation; this fact is not to be ascribed to more marked miosis, being rather, according to Duane,[3] due to a stronger activity of the ciliary muscle enforced by the impulse of convergence. When there is weakness of accommodation, the amplitude of binocular accommodation presents the same value as monocular accommodation, the latter being equal for both eyes in most cases. In only a few local conditions, as in the sequelae of iridocyclitis, have I seen unilateral weakness of accommodation. On the contrary, unequal accommodation of both eyes, a kind of aniso-accommodation, extremely rare in weakness of accommodation, is to be met with in pareses of accommodation associated with disturbances of pupillary reaction and other paralyses of ocular muscles, and also without other disturbances, as Flieringa found in a case of postdiphtheritic paralysis of accommodation (the near point of the right eye was at 75 cm. and that of the left eye at 7.5 cm.). The conditions resulting from the coincidence of weakness of accommodation and anomalies of refraction are, on the contrary, the same as those encountered in paresis of accommodation, although not of so marked a character. In hypermetropia, weakness of accommodation will make itself felt more readily than in emmetropia, and in the latter more readily than in myopia. A patient with myopia of high degree will not even become aware of it. In astigmatic patients fatigue asserts itself most quickly, for without weakness of accommodation such patients would make exorbitant use of accommodation. It is advisable first to correct any eventual anomaly of refraction as fully as possible, and then to proceed to the determination of the near point.

Moreover, weakness as well as paresis of accommodation can be ascertained only up to a certain age because of presbyopia. Nevertheless, older people may also present subjective complaints that bear the features of accommodative asthenopia and that also result from prolonged close work, in spite of relief by correcting glasses. In pure presbyopia such complaints are never made. What has been said is in favor of Flieringa's conception that the contractility of the ciliary muscle is still preserved after the age of 65, though it remains latent on account of the rigidity of the lens, in which process loss of elasticity of the lens fibers accompanies decrease of the refractive index. According to Donders, the relative amplitude of accommodation applies also to presbyopia.

3. Duane: Tr. Am. Ophth. Soc. **20**:132, 1922.

The practical test for weakness of accommodation is generally performed by bringing fine print closer and closer to the eye till the type becomes blurred. The distance between the print and the eye defines the near point and therefore, indirectly, the amplitude of accommodation. This method has proved useful in practice but unsuitable for finer tests of the amplitude of accommodation. This applies especially to comparative measurements of the condition prevailing in weakness of accommodation and of accommodative exhaustion due to protracted exertion of accommodation. For that purpose I devised the "accommodatometer" (fig. 1.), based on the lines of trial adopted by Landolt's ophthalmodynamometer.

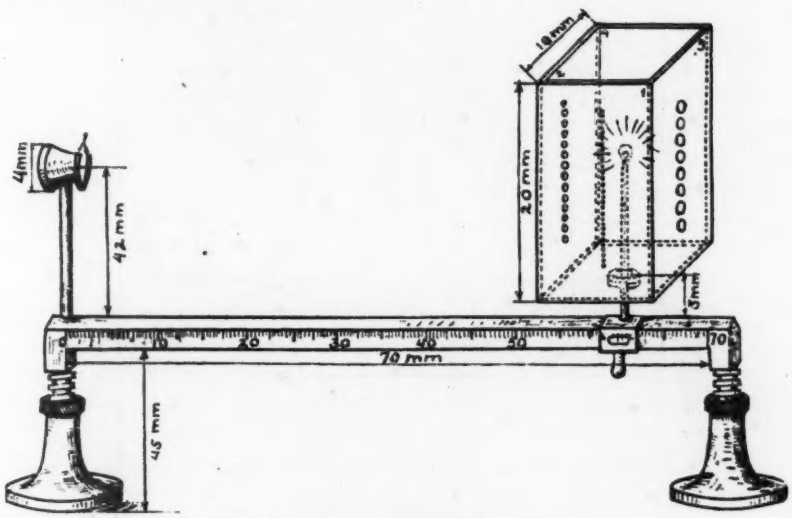

Fig. 1.—The accommodatometer.

THE "ACCOMMODATOMETER"

A pentagonal oxidated iron bar, as thick as one's little finger and 70 cm. in length, rests with both its extremities on stable stands, 15 cm. high. On the one side the iron bar is calibrated in centimeters ranging from 1 to 70 and presenting also the marks for 0.25, 0.5 and 0.75; on the other side it shows the corresponding data in diopters indicating the amplitudes of accommodation. On one end of the iron bar is mounted an immovable ocular ring of hard rubber. This ring is not deep, so that it may easily be brought to the orbital aperture; on its outer circumference, opposite the eye, is a semicircular groove nearly like the one in the trial frame. The transverse diameter of the ocular ring measures 4 cm. The opposite end of the iron bar is fitted with a small square box easily movable along the bar between the marks of 5 and 70 cm.; in addition, the box is rotatable on its vertical axis so that each side can, if necessary, be turned toward the ocular ring. The four walls of the box are of equal size and made of iron sheets colored black exteriorly. The upper and lower walls of the box are of the same color. Each of the four side-walls is provided with the necessary contrivances. The first side-wall possesses a straight row of small round holes.

The cavities of these holes tally with the lumen of the printed type of Snellen's chart D = 0.5. The second wall possesses similar but larger holes (the lumen of the letter o of Snellen's type D = 0.6); the third wall has still larger holes (the lumen of the letter o of Snellen's type D=0.8). The individual walls are lined with milk-white glass covering the holes. The fourth wall is movable up and down and possesses a slit two fingerbreadths high and several fingerbreadths wide. Behind this fourth movable sheet wall there is another fixed white glass wall, the inferior third of which is black while its other two-thirds show small print, namely, Snellen's charts D = 0.5, D = 0.8 and D = 1.25. The box contains an incandescent, not too strong, lamp of ground glass from which the cord

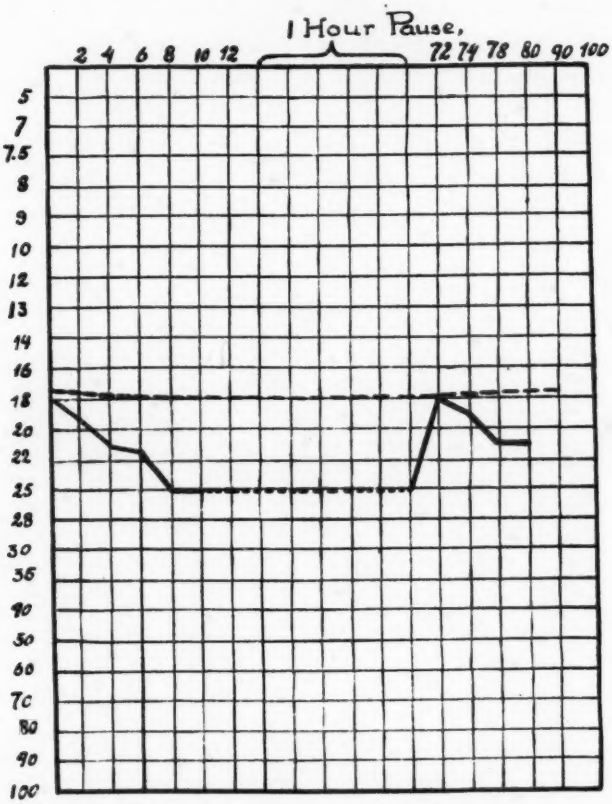

Fig. 2.—Accommodation curve in a case of weakness of accommodation. The dash line indicates the right eye, and the solid line the left eye. In this and subsequent charts, the vertical scale at the left indicates the distance of the near point in centimeters, and the scale at the top the time in minutes.

extends downward. By an adequate screw mounted on both stands, the iron bar, ocular ring and box can be pushed up and down to various heights.

The test is made in the dark room after vision and refraction have been examined minutely and exact information obtained about the condition of the eyeground and functions of the eye (field of vision, adaptation to light, color sense). The eye to be examined is fitted in the ocular ring and the other eye is blindfolded. In hyperopia, myopia and astigmatism the necessary correcting glass is inserted in the ocular ring. The lamp box is brought to 70 cm. from the eye

and turned into a position that places the wall with the smallest holes (*1*) in front of the eye, provided it has normal vision. If vision is reduced, then the sheet with the medium-sized (*2*) or largest (*3*) holes, conforming with the loss of visual acuity, is rotated into a position in front of the eye. After a suitable time has been allowed to elapse, the near point is obtained: The box is slowly slid toward the eye by means of the inferior handle, until the points have disappeared and only a vertical luminous light is perceived; as soon as the eye is no longer sharply adjusted to the points, the dispersion images of the luminous points overlap each other and coalesce into a somewhat wider light stripe. The near point can then be read sideways on the iron bar. The determination of the near point can also be made by means of the small print occupying the fourth side wall; when the box is turned with this face toward the eye and the black iron sheet is pushed upward, only the finest print (D = 0.5), clearly and homogeneously illuminated, becomes visible through the slit. When there is reduction of visual acuity, only the print D = 0.8 and D = 1.25 can be focused. Sliding

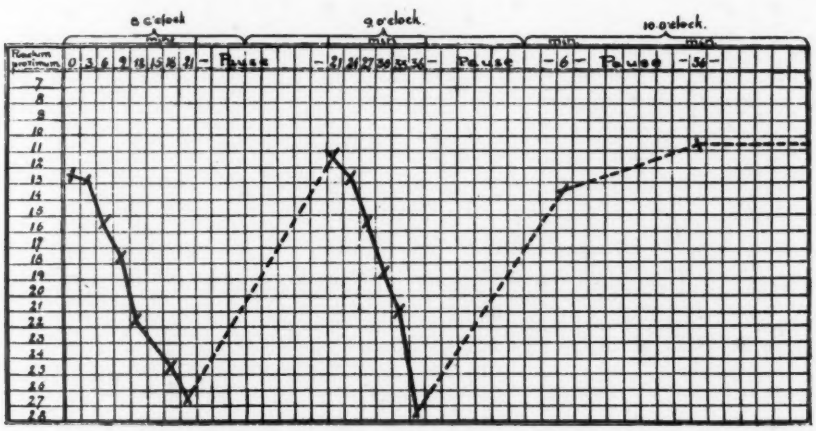

Fig. 3.—Accommodation curve in a case of cyclic weakness of accommodation. The dash lines indicate the pauses in the test.

the box forward and reading the near point is done in the same manner as when the holes are used. In order to avoid diagnostic errors as much as possible, when regular, not fully corrigible or irregular astigmatism is concerned, I had holes bored in the third side wall of the illuminated box. Thus, in addition to the test with vertically arranged luminous points, I was able to determine the amplitude of accommodation also by means of horizontally running, luminous points.

The accommodatometer permits one also to ascertain very slight degrees of weakness of accommodation, and especially to plot exhaustion phenomena of accommodation in an accommodation curve. Thus the annexed accommodation curve (fig. 2) shows the course of accommodation in a case of weakness of accommodation. Figure 3 reproduces the accommodation curve that I traced in a case of cyclic weakness of accommodation on the last day of menstrual flow in a patient with dysmenorrhea. With the aid of the accommodatometer one can make reliable records in the form of accommodation curves (as regards the duration and power of effect) covering the effects of the various chemical and other agents paralyzing accommodation (cocaine, atropine, racemic ephedrine) or

stimulating accommodation (pilocarpine, physostigmine). Figure 4 shows the tracing of an accommodation curve after the instillation of cocaine and pilocarpine.

The systemic diseases in which weakness of accommodation may be expected are those in which a toxic action on the nervous and brain centers may take place. This applies to all infectious febrile conditions, to poisonings, especially those typified by botulism, and also to disturbances of metabolism, such as diabetes. In all of them the anatomicopathologic lesions occurring in the brain centers are not irreparable as

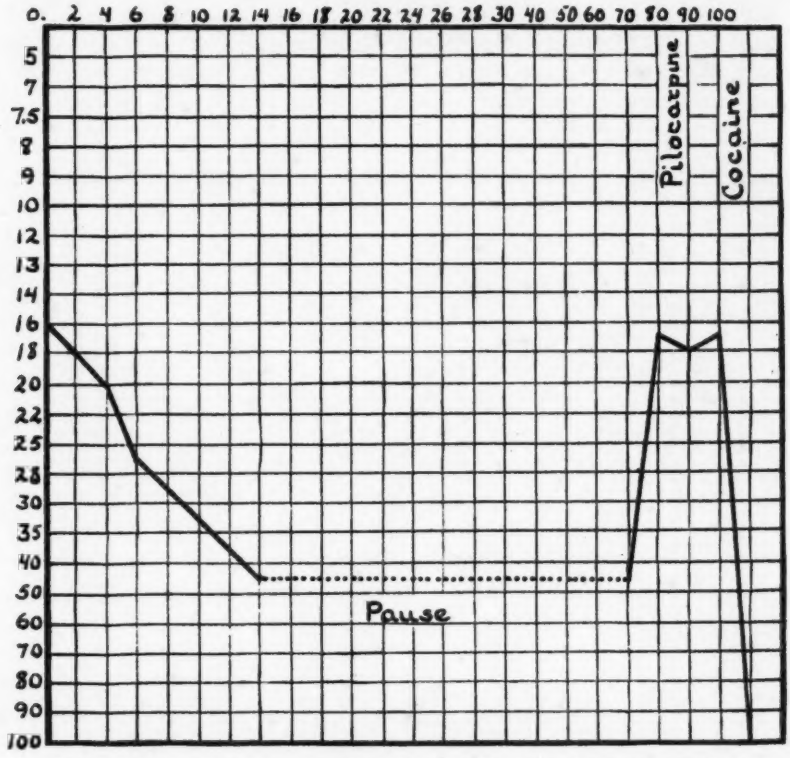

Fig. 4.—Accommodation curve after the instillation of cocaine and pilocarpine.

they are in diseases of the central nervous system, such as tabes dorsalis and cerebral syphilis. On the contrary, the lesions of the affected nervous centers due to the action of toxins are apt to recede, the curability of such cases of weakness of accommodation being the corollary. Of course, the initial symptom of a disease of the central nervous system may be only weakness of accommodation, a fact which accounts also for the conspicious diagnostic importance of detecting the eventual presence of weakness of accommodation, and it may develop into paresis or even paralysis of accommodation only in the further course of the disease of the central nervous system. On the other hand, the central toxic

effect in an infectious disease can also be so severe as to remove the near point very far and simulate the picture of a paralysis of accommodation. I have found weakness of accommodation in influenza and in scarlet fever, not only during the disease, but during the first prodromal manifestations and later in convalescence. In all infectious diseases, such as influenza, scarlet fever, measles, typhoid fever, paratyphoid fever, polyneuritis and catarrhal jaundice, weakness or paresis of accommodation may occur according to the strength of the toxic central effect. Variability of accommodation is frequently met with in the convalescence period of epidemic encephalitis. Often weakness of accommodation occurs in any condition of exhaustion. In the literature I have found the description of weakness of accommodation following overstrain due to mountain climbing (Guglianetti,),[4] after focal infection of the tonsils (Sumner),[5] after dystocia, during lactation and after severe hemorrhages, severe neurasthenia and masturbation. I have found weakness of accommodation of over one year's standing during lactation, pregnancy and dysmenorrhea. In all these cases a rapid decomposition of the proteins and absorption of the toxic substances thus formed is to be assumed. In the aforementioned case of dysmenorrhea there were also a pathologic constitutional predisposition (asthenic type of body build) and somatic endocrinologic alterations (infantilism of the sexual organs). Theobald recognized the essence of weakness of accommodation, terming it "subnormal force of accommodation" and meaning debility of the ciliary muscle as seen in exhaustive conditions, chlorosis, lactation and masturbation.

Among local diseases of the eye I have encountered weakness of accommodation in two cases of initial stages of glaucoma, in several cases of recently cured iridocyclitis and in one case of heterochromia of the iris. Foerster described a decrease of accommodative power in diffuse syphilitic chorioretinitis. Ishihara saw a similar alteration of accommodation, as he called weakness of accommodation, in a case of central retinitis, in his opinion due to empyema of the ethmoid sinus; in this case the near point of the diseased eye receded further and further on successive examinations.

How and by which route do endogenous and exogenous toxins attack so as to provoke weakness of accommodation? How and in which part does the physiologic activity of the ciliary muscle change so as to give rise to such delicate disorders of accommodation? With the aid of Pal's[6] theory of the decomposition of muscular functions and of adynamia and hypodynamia of muscles, it has become possible to gain

4. Guglianetti: Arch. di ottal. **30**:25, 1923; **31**:108, 1924.
5. Sumner: Am. J. Ophth. **4**:356, 1921.
6. Pal: Wien. klin. Wchnschr. **37**:537, 1924.

an insight into the highly differentiated function of the ciliary muscle. As Pal expressed it, adynamia means the lack of capacity for energetic performance of a muscle with preserved active motility, and hypodynamia means the possibility of a muscular performance not equal to the condition of the muscle. As Pal stated, the activity of each muscle cell involves two functions, namely, the kinetic function which provides for movement and the tonic function provided by the working stock, the substratum of the muscular performance. It is, of course, obvious that the tonic function of a muscle with circular function and disposition must play the same, and even a more important, part than does the kinetic function. In weakness of accommodation the kinetic function of the ciliary muscle is preserved, while the tonic function has been lost. When there is paresis of accommodation, both functions are decreased or even lost. It is not enough that the ciliary muscle is able to carry out the requisite movement, i.e., a contraction intended to act in the direction of Schlemm's canal; the contraction must also be performed with a certain amount of energy in order that the zonule may relax. Adynamia or hypodynamia of the ciliary muscle can only be spoken of when the kinetic function is unaltered. An adynamic muscle will become tired quickly. Adynamia and hypodynamia are pure physiologicopathologic conditions which need not at the same time be associated with anatomicopathologic lesions of the muscle. An adynamic ciliary muscle may even be hypertrophic. Not all cases that are considered as a paresis of accommodation are really palsy of the ciliary muscle; in some of these cases there is only adynamia or hypodynamia. The best example of adynamia and hypodynamia is offered by those deficiencies in muscular activity which are seen in myasthenia and congenital myotonia.

The tonic function of the ciliary muscle is under the strict control of the brain centers, owing to which fact the eye can be promptly adapted for the requisite distance. The surmise of an accommodation center in the brain is theoretically legitimate. In weakness of accommodation the tonic function is weakened in the form of hypodynamia or adynamia when the action of the toxins in the course of various diseases of the system is harmful to the accommodation center. Also after severe bodily strains or mental exertions and after insufficient sleep, the endotoxins formed as a result of excessive cell activity may act on the accommodation center and thus lead to weakness of accommodation. The medical literature also contains several reports in favor of the theory that an accommodation center exists in the brain, a toxic disease of the bulbar accommodation center being assumed in paresis of accommodation following epidemic encephalitis and the action of a blood-borne toxin on the nervous accommodation center being incrimi-

nated in disorders of accommodation following other febrile diseases. The numerous isolated disorders of accommodation encountered in many diseases, especially in those of the cerebrum, and in the most diverse diseases of the central nervous system and also in infectious diseases and disorders of metabolism, are decidedly in favor of the idea that there is an isolated brain center, the so-called accommodation center, charged with the regulation of the act of accommodation. It would be desirable to cite the corresponding inquiries of Relitzky, who found brain centers of this kind in dogs and monkeys.

SUMMARY

The disorders of accommodation should be given more attention in pathology, clinic and practice, for they are still playing a secondary part, although their exact diagnosis would disclose the proper seat of the complaints in many inexplicable ocular troubles and headaches. In examination of the eyes the exact determination of the accommodation, near point and accommodation time ought to be carried out in every case just as the vision and refraction of the eye are measured in any ocular examination. The simple method, however, of bringing test charts closer to the eye is not sufficient to determine the distance of the near point; it should be measured by methods objectively more the near point; it should be measured with adequate apparatus by methods objectively more accurate and more adjustable.

THE DISTURBANCES OF SENSIBILITY OF THE CORNEA AND CONJUNCTIVA IN XEROSIS AND KERATOMALACIA OF ADULTS

WITH A CONTRIBUTION TO THE EXPLANATION OF THE GENESIS OF THESE DISEASES *

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The frequent appearance of xerosis and keratomalacia in adults in North China, as already reported by Pillat,[1] has given me the opportunity to perform with more accuracy the examination of the generally known changes in the sensibility to touch of the cornea and the conjunctiva in the course of these diseases. On the basis of these observations, I venture to contribute to the explanation of the genesis of these diseases.

METHOD OF EXAMINATION

As test objects for examining sensibility, irritating hairs prepared after von Frey's [2] specifications were used. At one end of a thin wooden stick about 8 cm. in length a hair is fastened with sealing wax at right angles to the stick. The length of the hair varies according to the effect desired. The hairs used for such a test should be as straight as possible. Irritation is produced by holding the handle so that the tip of the hair touches the cornea and conjunctiva with pressure until the hair is observed to bend a little. The irritation value of the test hair depends (1) on its caliber or touching surface and (2) on its resistance to bending. To compute the touching surface of the hair, its diameter was measured on the microscope with an ocular micrometer. The bending resistance of the hair was measured on a precision balance by pushing one pan of the balance down with the hair tip, the weight being in the other pan, which balanced the pressure exerted by the pushing hair, registering the pressure power over the hair.

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* From the Department of Ophthalmology of the Peiping Union Medical College.

1. Pillat, Arnold: The Main Symptoms of the Eye in Vitamin A Deficiency in Adults, Nat. M. J., China **40**:614, 1929; The General Symptoms of Keratomalacia of Adults, China M. J. **43**:907, 1929; Does Keratomalacia Exist in Adults? Arch. Ophth. **2**:256 and 399 (Sept.-Oct.) 1929; The Frequency of Deficiency Diseases of the Eye Due to Lack of Vitamin A in a Military Camp North of Peiping, Nat. M. J., China **40**:585, 1929; Ueber Praexerosis und Xerosis corneae als selbstaendige Krankheitsbilder der Mangelkrankheit des Auges beim Erwachsenen, Arch. f. Ophth. **124**:486, 1930.

2. von Frey, in Tigerstedt: Handbuch der physiologischen Methodik, 1914, vol. 3, p. 14.

From these two values, that is, the touching surface and the resistance power, the pressure value of the hair is obtained. This is equal to the quotient of pressure power divided by the touching surface:

$$\frac{\text{pressure power}}{\text{touching surface}} = \frac{\text{g}}{\text{qmm}} = \text{pressure value}$$

Other authors have not taken into consideration the caliber of the test hair, using as the unit only the pressure power found on the balance, but in my tests I employed von Frey's unit of g/qmm, so as to be able to compare my observations with those obtained by von Frey and Strughold [3] from the cornea and conjunctiva of the normal human eye. To facilitate comparison of the different observations, only hairs of one quality and caliber were used—hairs from the heads of human beings, with a radius of 0.045 mm.

Because the conjunctivae of the patients examined were often superabundant with pathogenic germs, and, as a rule, were also involved with trachoma, the irrita-

TABLE 1.—*The Measurements of the Different Test Hairs: The Radius of All the Test Hairs is the Same, 0.045 mm.; the Touching Surface of All, 0.0063 qmm.*

Number of Hair	Maximum Pressure Power, Mg.	Pressure Value, g/qmm
1	1.89	0.3
2	3.15	0.5
3	6.30	1.0
4	31.50	5.0
5	63.00	10.0
6	126.00	20.0
7	189.00	30.0
8	252.00	40.0
9	315.00	50.0
10	378.00	60.0

tion hairs were cleared with alcohol after each test. It was found that the pressure value of each test hair was in the course of time diminished by use, most probably because of the cleaning with alcohol. This degree of diminution, however, was so negligible that the use of the same test hairs for the purpose of checking the sensibility of the corneas and conjunctivae of the same patients in the process of healing of the xerotic condition could not be taken as a source of error. For instance, at the end of the examinations when the test hairs had been used for five months, the pressure value of each test hair was found to have diminished from 2.5 by not more than 6 per cent, a diminution that is entirely negligible, especially in the light of the marked diminution of corneal sensibility, to be reported.

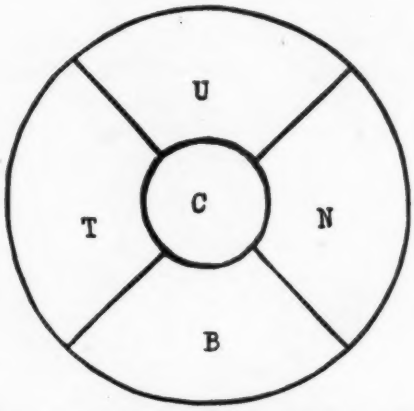
Altogether ten test hairs, with pressure values increasing from 0.3 to 60 g/qmm, have been used. Table 1 shows the maximum pressure power of these different test hairs in milligrams, and the pressure value of each test hair in g/qmm.

The examinations were performed in the usual way with the patient flat on his back with the head slightly raised and the eyes fixated as well as possible on a

3. von Frey and Strughold: Weitere Untersuchungen über das Verhalten von Hornhaut und Bindehaut des menschlichen Auges gegen Beruehrungsreize, Ztschr. f. Biol. **84**:321, 1926.

point on the ceiling. The lids of the patient were held apart by the fingers of the examiner's left hand, and following von Frey's method the test hairs were applied vertically, care being taken not to overbend them.

Marx,[4] in determining and localizing the sensibility of the cornea of the human eye, divided the area of the cornea into thirty-three examination fields, Schroeder[5] into sixteen and von Frey and Strughold into seventeen fields. As I was more interested in knowing the degree of diminution of the sensibility of the cornea and conjunctiva in keratomalacia and xerosis of the eye than in determining the comparative localities of the changes in sensibility of the cornea, I thought it practical to simplify this particular schema into five fields, as illustrated in the accompanying diagram. This gives the possibility of comparing in sensibility the center only of the cornea with the peripheral sectors. In the diagram the central field, *C*, is the same as von Frey and Strughold's zone O, and the peripheral sectors, *U*, *T*, *B* and *N*, are the same as their zone I.



Division of the area of the cornea for determining and localizing the sensibility of the cornea of the human eye. *C* indicates the central field, and *U*, *T*, *B* and *N*, the peripheral sectors.

In examining the conjunctiva, von Frey and Strughold divided the bulbar conjunctiva into twenty-four different test fields and the upper and lower palpebral conjunctiva each into six fields. For my purpose it seemed sufficient to examine the bulbar conjunctiva in its four quadrants, upper, temporal, lower and nasal, at a region midway between the limbus and the retrotarsal folds, which corresponds to zone IV of von Frey and Strughold. I have also simplified the examination of the conjunctiva of the upper and lower lid to an area lying in the region of the proximal margin of both tarsi, corresponding to von Frey and Strughold's zone VI. In each of these corneal and conjunctival test fields, the same hair was applied five times at intervals of two seconds, and in the diagrams the lowest pressure value felt by the patient in this particular field was noted.

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4. Marx: De la sensibilité et du desséchement de la cornée, Ann. d'ocul. **158**:774, 1921. (I regret that the book of Marx entitled "Die Empfindlichkeit der menschlichen Hornhaut," Leipzig, S. Hirzel, 1923, was not at my disposal.)

5. Schroeder: Prüfung der Hornhautempfindlichkeit nach operativen Eingriffen, Arch. f. Ophth. **111**:17, 1923.

The corneal and conjunctival region in the immediate vicinity of the limbus, in which von Frey and Strughold found the relatively lowest sensibility of the cornea as well as of the conjunctiva, was not specially examined. However, the sensibility of phlyctenules, xerotic spots of the cornea and conjunctiva, corneal ulcers and prolapse of iris were studied in particular.

NORMAL CONTROL CASES

Recognizing the generally observed tolerance of the Chinese people to pain, the suspicion of a comparatively lower sensibility of the cornea and conjunctiva even in normal Chinese eyes as compared with those of Westerners was justifiable. To verify this, the sensibility of the cornea and conjunctiva of four Chinese with normal external condition

TABLE 2.—*Test Cases: The Average Grades of Sensibility of the Cornea and Conjunciva in Externally Normal Eyes of Western and Chinese People Given in g-qmm Pressure Value of the Test Hairs*

Case	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1 (von Frey and Strughold's figures in normal European eyes).....	0.2	0.36	22.8	11.7
2 (L. S. F., a Chinaman, aged 22, with normal eyes).....	0.3	0.5	20.0	15.0
3 (M. C. L., a Chinaman, aged 23, with central choroiditis in both eyes)	0.3	0.5	20.0	12.9
4 (H. T. S., a Chinaman, aged 22, with retrobulbar neuritis in both eyes)	1.0	5.0	25.2	....
5 (L. H. L., a Chinaman, aged 30, with syphilitic neuroretinitis in both eyes)	5.0	8.1	50.0	45.0

of the eyes was examined. Table 2 shows the observations, together with the values found in normal eyes of Westerners by von Frey and Strughold. In table 2 and all the following tables it is to be noted that the figures represent only the average lowest pressure value of all the observations made in the circular zones of the corneal periphery, the bulbar conjunctiva and the conjunctiva of the lid, as was done by von Frey and Strughold in the different zones of the cornea and conjunctiva.

From table 2 it can be observed that the average sensibility of the cornea and conjunctiva in two cases in Chinese (cases 2 and 3) is almost the same as that found by von Frey and Strughold in examinations of Western eyes. Case 4 in table 2 is that of a Chinese suffering from retrobulbar neuritis, which is found relatively often in the Chinese, but the cause of which is at this time undetermined, who showed a moderate decrease in sensibility of the cornea, while in case 5, that of a patient with syphilitic neuroretinitis, there was a marked decrease in sensibility of the cornea and conjunctiva. The latter case, however,

cannot be considered as a fit test case for sensibility in a normal cornea and conjunctiva, because Stern [6] found decreased sensibility in a Westerner with syphilitic neuroretinitis, but also with slight visible changes in the cornea. This leads one to think that in case 4 there may be some connection between retrobulbar neuritis and the decrease in sensibility.

TABLE 3.—*Keratomalacia with Perforation of the Cornea and Prolapse of the Iris of One Eye. The Fellow Eye Shows Only Xerosis of the Cornea and Conjunctiva, Pigmentation of the Bulbar and Palpebral Conjunctiva and Wrinkling of the Bulbar Conjunctiva* *

Case	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1 (L. S. L., a boy, aged 18).....	20	20	30	30
2 (T. T. S., a man, aged 29).....	10	10	50	45
3 (S. L. Z., a man aged 20).....	20	15	60	45

* In this and the following tables the figures give the pressure value of the test hairs in g/qmm.

TABLE 4.—*Xerosis and Prexerosis of the Cornea with Xerosis, Pigmentation and Wrinkling of the Conjunctiva*

Case	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1 (L. T. P., a boy, aged 17).....	10	20.0	54.6	....
2 (H. C. L., a man, aged 26).....	5	10.0	31.4	....
3 (M. H. C., a boy, aged 18).....	5	5.0	27.5	....
4 (C. H. T., a boy, aged 17).....	5	10.0	45.0	60.0
5 (L. H. S., a man, aged 22).....	10	20.0	57.5	30.0
6 (K. H. L., a woman, aged 26).....	20	20.0	47.5	37.5
7 (W. C. C., a boy, aged 19).....	10	10.0	55.0	22.5
8 (L. C. L., a man, aged 22).....	20	20.0	55.0	50.0
9 (W. F. T., a man, aged 20).....	5	5.0	45.7	30.0
10 (C. Y. L., a man, aged 42).....	10	7.5	42.5	40.0
11 (C. S. Y., a man, aged 22).....	5	5.0	45.0	40.0
12 (C. C. H., a boy, aged 16).....	5	8.7	30.0	25.0

PATHOLOGIC CASES

The eyes of twenty patients with xerosis of the cornea and conjunctiva were examined for changes in sensibility for one or more times in each case. Three of these patients had keratomalacia of one eye, twelve had xerosis and prexerosis of the cornea and xerotic changes in the conjunctiva, five had prexerosis of the cornea without xerotic spots on the conjunctiva, and two of them showed Bitot's spots as the only sign of xerotic changes. Otherwise the corneas and conjunctivae of these patients were normal. The observations of sensibility of the cornea and conjunctiva at the time of the first consultation are given in tables 3, 4, 5 and 6. Table 3, which deals with three cases of kerato-

6. Stern: Ueber ein bisher unbekanntes Hornhautphaenomen bei Trigeminusanaesthesie, Klin. Monatsbl. f. Augenh. **46**:465, 1908.

malacia, records the sensibility of the fellow eye, which was not involved with keratomalacia but showed marked changes of xerosis of the cornea and large irregular xerotic spots in the bulbar conjunctiva. Besides this there existed a dense pigmentation of the lower retrotarsal fold, the plica and caruncle, also less intense pigmentation of the upper retrotarsal fold, and of the bulbar and palpebral conjunctiva, and a rough wrinkling of the bulbar conjunctiva. Table 4 deals with a group of twelve patients with xerosis and prexerosis of the cornea. The bulbar conjunctiva of these patients showed Bitot's spots and sometimes also larger irregular xerotic spots, and wrinkling and pigmentation of the conjunctiva as in the cases of keratomalacia shown in table 3, but

TABLE 5.—*Prexerosis of the Cornea, Pigmentation and Wrinkling of the Conjunctiva, But No Definite Xerosis of the Bulbar Conjunctiva*

Case	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1 (H. C. L., a man, aged 28).....	5	10	45	40
2 (L. T. P., a man aged 35).....	10	20	More than 60	25
3 (W. Y. Z., a boy, aged 17).....	10	10	30	15

TABLE 6.—*Bitot's Spots, Nonpigmentation and Nonwrinkling of the Conjunctiva. The Cornea is Lustrous and Clear*

Case	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1 (W. S., a man, aged 20).....	0.3	0.5	20.0	20.0
2 (C. S. C., a man, aged 23).....	0.3	0.75	22.0	15.0

these changes were less marked in most of the cases appearing in table 4. In table 5 are recorded the observations of sensibility in the eyes of three patients with prexerosis of the cornea. The main symptoms of prexerosis described by Pillat are a slight loss of luster of the cornea, reduced sensibility, the typical bacteriologic observation of xerosis bacilli in the degenerated epithelial cells of the cornea and the "drying-out-symptom" of the cornea, which is present after keeping the cornea exposed for from five to ten seconds by retracting the lids. The conjunctiva of these patients showed a wrinkling and pigmentation and also a lack of luster, but no xerotic spots could be observed, not even in the form of a small Bitot's spot. In table 6 are given the results of the sensibility test in the eyes of two patients with an entirely normal, lustrous, clear cornea, pale bulbar conjunctiva and typical Bitot's spots as the only sign of xerosis. With the exception of the patient with keratomalacia in one eye, in which case only the fellow eye was examined, both eyes were examined in all cases. The sensibility of each eye was often

different. In tables 4, 5 and 6 is given only the corneal and conjunctival sensibility of that eye in which the sensibility was more markedly diminished.

The small number of patients examined is due to the extreme difficulty of getting patients for examination who could give reliable answers concerning the sensitivity of the cornea and conjunctiva to touch. It should be emphasized here, as also mentioned by Pillat, that patients with keratomalacia showed marked mental numbness, which was certainly not an evidence of Asiatic tolerance to pain, because the psychic attitude of these patients changed markedly in the course of healing of the disease of the eye and was found to be normal at the reexaminations performed after several weeks and months. Similar observations of characteristic apathy in children with keratomalacia are mentioned by Fuchs in his textbook [7] and by many other authors, while Bloch [8] found that children with keratomalacia in the first stage of the disease were conspicuously indolent, and in the stages following often extremely irritable. Stoelte [9] also emphasized the irritability of children with keratomalacia.

In reviewing tables 3, 4, 5 and 6 it is found that all patients who have diseases of the eye involving the cornea which are thought to be the consequence of lack of vitamin A in the diet have a marked diminution of sensibility of the cornea and a much less marked diminution of the sensibility of the conjunctiva, which Pillat mentioned in general. The diminution of corneal sensibility is most marked in the cases appearing in table 3, in which the keratomalatic decomposition of the cornea is an indicator of the severest stage of these xerotic diseases. The grade of pressing power felt by these patients in the corneal center is 50 or 100 times higher than in normal eyes. Half of the patients, however, grouped under table 4, whose corneas of both eyes showed only xerosis and prexerosis, without any signs of infiltration or decomposition, and whose conjunctiva also showed xerotic spots, had the same high grade of diminution of sensibility as the patients with keratomalacia of one eye. The other half of the patients in table 4 with xerotic changes of cornea and conjunctiva, had a diminution of sensibility in the center of the cornea, which was increased 25 times. Of the 3 patients in table 5 with xerosis and prexerosis of the cornea, but without definite symptoms of xerosis of the conjunctiva, 2 had a grade of pressing power felt on the corneal center 50 times higher, and the

7. Fuchs: Lehrbuch der Augenheilkunde, ed. 15, Vienna, Franz Deuticke, 1926.

8. Bloch: Klinische Untersuchungen über Dystrophie und Xerophthalmie bei jungen Kindern, Jahrb. f. Kinderh. **89**:405, 1919.

9. Stoelte: Ueber Keratomalacie, Klin. Monatsbl. f. Augenh. **68**:739, 1922.

other a grade 25 times higher, in comparison with the normal corneal center. From this it seems that there is no difference in the diminution of corneal sensibility whether the conjunctiva also has xerotic changes or not. It should be noted, nevertheless, that none of the 3 cases in table 5, in which there were no xerotic spots on the conjunctiva, showed the highest degree of diminution of sensibility in the corneal center, which was found in two thirds of the cases of keratomalacia with 20 g/qmm pressure value, and in one sixth of the cases with xerosis of cornea and also xerosis of the conjunctiva appearing in table 4. This makes it clear that in these cases the degree of diminution of sensibility in the cornea is in proportion to the severity of the xerotic changes in the cornea. Further, the 2 cases in table 6 make it evident that xerotic changes in the eye in the form of Bitot's spots are present before disturbances of sensibility set in. From these observations it may be stated that diminution of sensibility in the cornea occurs only when changes in the cornea appear at least in the form of prexerosis.

It is remarkable that in many cases the sensibility of the corneal center is more disturbed than that of the corneal periphery. In the normal eye the sensibility in the corneal center is almost twice as high as that in the corneal periphery, but I found that in two thirds of my cases of keratomalacia (table 3, cases 1 and 2) the sensibility of the corneal center was the same as that in the corneal periphery. This means that the sensibility in the corneal center is reduced relatively two times more than that in the corneal periphery. The same pathologic relation between the sensibility of the corneal center and that of the corneal periphery was found in six cases in table 4 (cases 3, 6, 7, 8, 9 and 11) and in one case in table 5 (case 3). There were even some cases in which the sensibility of the corneal center was less than that in the corneal periphery (case 3, table 3, and case 10, table 4); on the other hand, the two cases (table 6) with Bitot's spots, with otherwise normal cornea and conjunctiva, showed also quite normal values in the relation between the sensibility of the corneal center and that of the corneal periphery, a fact which speaks also for normal sensibility in beginning xerotic cases.

The sensibility of the bulbar conjunctiva is much less diminished than the corneal sensibility in all cases of keratomalacia and xerosis; in other words, the pressure value is only from one and one-half to two and one-half times higher than that in normal eyes. There is no constant relation between the degree of diminution of corneal sensibility and bulbar conjunctival sensibility; for example, the highest degree of diminution of corneal sensibility observed in case 1 of table 3 was associated with a low degree of diminution of sensibility of the bulbar conjunctiva. On the other hand, a comparatively moderate decrease of

corneal sensibility as in cases 9 and 11 of table 4, is combined with a relatively high diminution of sensibility of bulbar conjunctiva. The highest diminution of the sensibility of the bulbar conjunctiva was found in a case of prexerosis of the cornea, without xerotic changes in the conjunctiva. The two cases in table 6 with normal sensibility of the cornea showed also a normal sensibility of the bulbar conjunctiva.

In all patients the sensibility of the palpebral conjunctiva is diminished relatively to a higher degree than that of the bulbar conjunctiva, so that the grade of their pressure values is from three to four times higher than that in normal eyes. In the palpebral conjunctiva the decrease of sensibility is not in proportion to the degree of diminution of corneal sensibility, and in some cases the relation in sensibility between even the palpebral and the bulbar conjunctiva is not the same. Case 4 of table 4 is an example in which the sensibility of the palpebral conjunctiva was much more diminished than that of the bulbar conjunctiva, whereas in normal cases the sensibility of the palpebral conjunctiva is twice as great as that of the bulbar conjunctiva. These seeming discrepancies, however, in the diminution of sensibility of the bulbar and palpebral conjunctiva in relation to one another and to the corneal sensibility may be due to the intensity of the concomitant inflammation of the conjunctiva, which was found in almost all of the xerotic cases and also in the cases free from trachoma. This fact is already known from Nagel's [10] observations that the sensibility of the conjunctiva in the stage of inflammation may be considerably reduced.

Phlyctenas were found in many of the cases of keratomalacia and xerosis, most of them being very large, broken down and numerous, and not exclusively confined to the region of the limbus, but often found also in the peripheral parts of the bulbar conjunctiva and in the palpebral conjunctiva. The phlyctenas of the palpebral conjunctiva were situated particularly along the upper and lower margins of the lids, where they were stereotyped on their corresponding places; that is, the places where the margins touch each other when the lids are closed. The sensibility of the phlyctenas was always more decreased than that of the surrounding conjunctiva. It seems remarkable that the simple Bitot's spots often show a better sensibility to test hairs than the conjunctiva in the surrounding area. The Bitot's spots were not uniformly dull, but showed some islets where the luster was just the same as that in the normal conjunctiva. Whether these lustrous areas within the Bitot's spot were places in which the conjunctival tissue was more resistant against the factors producing the xerotic changes or whether

10. Nagel: Die Sensibilitaet der Conjunctiva und Cornea des menschlichen Auges, Arch. f. d. ges. Physiol. **59**:563, 1895.

they were signs of beginning healing of the xerotic changes could not be determined, but the large irregular xerotic spots that were found mostly in the lower parts of the bulbar conjunctiva joining the limbus, contrary to the aforementioned Bitot's spots, had from the first been found extremely diminished in sensibility. Similarly, the xerotic spots of the cornea showed a more decreased sensibility than the other less opaque parts of the same cornea. In the three cases of keratomalacia the prolapsed iris was insensible to the strongest test hair with a pressure value of 60 g/qmm.

AFTER-TEST

The condition of the sensibility in the cornea and conjunctiva in the course of healing of the keratomalatic and xerotic processes due to treatment with cod liver oil could be checked up in the eyes of the three patients with keratomalacia in table 3 and in the five patients with xerosis of the cornea and conjunctiva in table 4. Tables 7 and 8 give the observations of the after-test, made once or more at intervals of from eight days to five months.

In almost all of the cases checked up the sensibility of the cornea improved only slowly. Five months after the first observation, when the xerotic process of the cornea and conjunctiva had been healed a long time, with only slight pigmentation of the conjunctiva, the values of sensibility in the cornea and conjunctiva in three fourths of these cases were not yet approximately normal. The two cases in table 8 (cases 2 and 6), in which normal values of the sensibility to touch in the cornea were found three and one-half and five months after the first observation, were cases of xerosis of the cornea; no similar healing of disturbances of sensibility was found in the cases of keratomalacia in table 7. This gives the impression that the duration of the changes in sensibility is also dependent to a certain extent on the degree of severity of these diseases. Whether or not the sensibility in cases of keratomalacia is completely normal after healing cannot be decided at the present time, because the period of observation is perhaps too short.

For all of the cases of xerosis 30 Gm. of cod liver oil daily was prescribed. Prescription of other nourishment seemed to be without any value, because most of the patients were soldiers and the rest were persons whose social and financial status would not allow any improvement in diet. It is possible that the slow and incomplete improvement in sensibility in the patients who were never admitted to the clinic, but came only a few times for checking up, was probably caused by neglect in carrying out the therapeutic prescription. However, it is probable that every one of them took at least the amount of 200 cc. of cod liver oil prescribed at the first examination, because the visible xerotic changes

of the cornea and conjunctiva improved rapidly. A reliable checking up of the cod liver oil and other nourishment rich in vitamin A taken could be done only in the case of patients with keratomalacia who were inpatients for several weeks. But in the cases of keratomalacia strictly given nourishment containing vitamin A, I also found in only one case (case 1, table 7) an improvement in the sensibility of the cornea after

TABLE 7.—*After-Observations of the Cases with Keratomalacia Appearing in Table 3*

Case	Date of Examination	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
1	First examination	20	20	30.0	30
	After 8 days	10	5	32.5	30
	After 2½ months	5	5	35.0	30
2	First examination	10	10	50.0	45
	After 12 days	10	10	42.5	20
3	First examination	20	15	60.0	50
	After 8 days	20	20	More than 60.0	50
	After 2¼ months	10	10	50.0	50
	After 5 months	5	5	50.0	20

TABLE 8.—*After-Observations in the Cases of Xerosis of the Cornea and Conjunctiva in Table 4*

Case	Date of Examination	Corneal Center or Zone 0	Corneal Periphery or Zone I	Bulbar Conjunctiva or Zone IV	Palpebral Conjunctiva or Zone VI
2	First examination	5.0	10.0	31.4	....
	After 3½ months	0.3	0.5	20.0	20.0
5	First examination	10.0	20.0	57.5	30.0
	After 9 weeks	5.0	10.0	50.0	30.0
	After 5 months	5.0	5.0	30.0	30.0
6	First examination	20.0	20.0	47.5	37.5
	After 7 weeks	10.0	10.0	45.0	25.0
	After 5 months	0.5	1.0	25.0	15.0
8	First examination	20.0	20.0	55.0	50.0
	After 6 weeks	5.0	5.0	22.5	20.0
9	First examination	5.0	5.0	45.7	30.0
	After 10 days	5.0	5.0	37.5	30.0

eight days, whereas case 3 of table 7 showed, after eight days' treatment with vitamin A, a still further decrease of sensibility of the corneal periphery, in spite of the fact that improvement of the xerotic conditions in the cornea and conjunctiva was already visible. I should like to mention here that following the experience of Pillat the patients with keratomalacia whose corneas were infiltrated but not yet perforated were usually given only small beginning doses of cod liver oil, that is, 5 Gm. each day, because it was observed that in such cases after a beginning dose of as much as 30 Gm. the cornea on the next day was found totally destroyed in the areas of infiltration, leading to large prolapses of the iris.

CONCLUSION

Considering the course of disturbance of sensibility in relation to the visible changes in the cornea and conjunctiva in cases of keratomalacia and xerosis, it seems justifiable to place the etiology of the diseases, like that of keratitis neuroparalytica, as trophoneurotic. Therefore, before attempting to prove my statement that keratomalacia and xerosis are of trophoneurotic genesis, it seems advisable to present briefly the theories on the trophoneurotic origin of keratitis neuroparalytica.

Magendie,[11] in considering his experiments performed on animals by cutting through the nervus trigeminus, stated that the nervus trigeminus must have a direct influence on the nourishment of the cornea. He postulated that the trophic fibers join the nervus trigeminus in the ganglion gasseri, most probably through the agency of the nervus sympathicus. Behr[12] recently emphasized the theory of the trophoneurotic origin of keratitis neuroparalytica in the latest textbook of Wilbrand and Saenger, "Neurologie des Auges," and in a separate article written after observations on keratitis neuroparalytica following the injection of alcohol into the ganglion gasseri. He is of the opinion that these affected trophoneurotic fibers belong to the nervus sympathicus, and that it is not the deficiency or loss of trophic function that produces the keratitis neuroparalytica, but irritation of the descending portion of the nervus sympathicus running into the trigeminus. This trophoneurotic theory is so far the most satisfactory theory to most authors interested in this question since Magendie. Opinion, however, has not been unanimous as to the place in which the changes of the ramus ophthalmicus are situated. Behr and most other authors believed that the changes occurring in the ganglion gasseri were mainly responsible for keratitis neuroparalytica and that changes in the other parts of the ramus ophthalmicus might also be a causative factor, while Lagrange[13] was of the opinion that a lesion of the ganglion ciliare was the primarily responsible factor in the changes characteristic of keratitis neuroparalytica. Shiraishi[14] confirmed this theory with his experiments on dogs. He found that after extirpation or irritation of the ganglion

11. Magendie: J. de physiol. expér., 1824, part 4, referred to in Wilbrand-Saenger: Die Neurologie des Auges, Munich, J. F. Bergmann, 1901, vol. 2.

12. Behr, in Wilbrand-Saenger: Die Neurologie des Auges in ihrem heutigen Stande, ed. 1, Munich, J. F. Bergmann, 1927; Ueber die Grundlagen der Keratitis neuroparalytica, Ztschr. f. Augenh. **62**:1, 1927.

13. Lagrange: La kératite neuroparalytique, ses variétés, sa pathogénie, Bull. Acad. de méd., Paris **88**:288, 1922; Zentralbl. f. ges. Ophth. **8**:343, 1923.

14. Shiraishi: Einfluss der Quetschung und Extirpation des Ganglion ciliare auf die Hornhaut des anderseitigen Auges, Arch. f. Ophth. **120**:576, 1928.

ciliare there appeared a keratitis neuroparalytica not only in the eye on the side on which the ganglion ciliare were affected by artificial lesion, but also in the fellow eye.

Keratomalacia and keratitis neuroparalytica are diseases similar in appearance. The symptoms are enumerated, for instance, in Fuchs's "Lehrbuch" as follows: "the dryness of these eyes, the very slight irritation symptoms in relation to the heavy keratitis, the lack of profuse lacrimation, and the lack of blepharospasm and of pains." In former times these two diseases were thought to be based on the same pathogenesis, and Graefe,[15] in 1866, was the first to separate keratomalacia with xerosis in young children as a different disease from keratitis neuroparalytica following traumatic or other changes in the ganglion gasseri. As a characteristic difference between these two diseases, in his cases of keratomalacia he found a diminution of sensibility of the cornea and conjunctiva, but not a total absence of sensibility as in the cases of keratitis neuroparalytica. He attributed the cause of keratomalacia to trophoneurotic changes in the eye following pathologic changes in the brain. A year before Virchow[16] had called these pathologic changes in the brain an "encephalitis infantilis" which caused the death of young children. The characteristic changes of the brain in this disease were described by him as hyperemia of the white substance of the brain, which contains numerous fat-granular cells. Graefe found the same changes in the brains of two children, 3 and 4 months of age, with keratomalacia and xerosis, and thought that these changes of the brain were the cause of the trophoneurotic changes in the eye. He emphasized also that this encephalitis most probably could be only a part of a general disturbance in nourishment in children. Jastrowitz[17] contradicted Graefe's opinion with the argument that the changes in the brain of the so-called cases of "encephalitis infantilis" could be found, as a rule, in the brain of any normal child in the first months of life. When Jacusiel[18] twenty-five years later in the Berlin Medical Society once more defended Graefe's theory of "encephalitis infantilis" as the cause of keratomalacia, he found many opponents, especially Hirschberg,[19] who mentioned that it was difficult for him to differentiate

15. Graefe: Hornhautverschwärung bei infantiler Encephalitis, Arch. f. Ophth. **12**:250, 1866.

16. Virchow: Address delivered before the Natural Scientific Society, Hanover, 1865; quoted by Behr: Arch. f. Ophth. **29**:227, 1883.

17. Jastrowitz: Studien über die Encephalitis und Myelitis des ersten Kindesalters, Arch. f. Psychiat. **2**:389, 1870; **3**:162, 1872.

18. Jacusiel: Ein Fall von Encephalitis interstitialis diffusa mit consecutiver Keratitis duplex ulcerosa, Berl. klin. Wchnschr. **20**:96, 1883.

19. Hirschberg: Ueber die durch Encephalitis bedingte Hornhautverschwärung bei Kindern, Berl. klin. Wchnschr., 1868, no. 31, p. 324.

a normal from a pathologic brain, and that he never found any changes in the nervi trigemini of children with keratomalacia which could strengthen the theory of a neuroparalytic disease.

Leber,[20] in his comprehensive paper on xerosis of the conjunctiva and infantile keratomalacia, also disagreed with the theory of the neurotropic genesis of the disease, because he also found no pathologic changes at autopsy in the brain and trigeminus of a child with keratomalacia. One of his main arguments against the trophoneurotic theory was that in this disease both eyes were involved and that the diminution of sensibility was confined to the region of the eyeballs only. As regards the cause of diminution of sensibility, Leber thought that the extreme changes of the epithelium of the eye disturb the intra-epithelial nerve fibers. It is known that he believed that the epithelial changes were caused by parasitic elements. This theory of Leber's, attributing the cause of keratomalacia to germs, was accepted by many authors at the time it was first stated.

In 1890, Cirincione[21] published the autopsy observations in a case of keratomalacia in an adult. The case was that of a woman, aged 25, who died of an abdominal tumor from which she had suffered for three years. In the last two years she had hemeralopia which in the last year was combined with anesthesia of both corneas and xerosis. Later on the corneas were infiltrated and perforated. The conjunctiva was also somewhat anesthetic. The anatomic observations showed a perineuritis of the optic nerve and signs of chronic inflammation in the ganglia ciliaria and ganglia gasseri. The ganglion cells were degenerated, pigmented and vacuolized. An infiltration of small cells surrounded the vessels in the periphery of the ganglions and also invaded the spaces between the nerve cells. The capsule and the connective tissue of the ganglions were thickened. Following these pathologic observations Cirincione concluded that the clinical picture was that of a disturbance of innervation of the trigeminus.

As far as my review of the literature goes, I have not been able to find similar reports by other authors, nor even similar examinations of the ganglion and optic nerve in keratomalacia. There are, however, reports of changes in the brain, spinal cord and nervous system in experimental keratomalacia in rats, as described in Stepp and György's textbook.[22]

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20. Leber: Ueber die Xerosis der Bindehaut und die infantile Hornhautverschwärung, Arch. f. Ophth. **29**:226, 1883.

21. Cirincione: Lesioni nervose nella xerosi con emeralopia, Gior. di neuropatol., 1890, vol. 7.

22. Stepp and György: Avitaminosen und verwandte Krankheitszustände, Berlin, Julius Springer, 1927.

In recent years Gonzalez,[23] following his observations on fifty-eight children with keratomalacia, stated that the necrosis of the cornea must be a trophoneurotic involvement based on a disturbance of the nervus sympathicus. This disturbance is caused by heavy changes in the suprarenal glands due to lack of vitamin A. Finally, Pillat reported his observations of thickened corneal nerves seen by the slit-lamp in some cases of keratomalacia. In his last paper concerning keratomalacia he came to the conclusion that it could be possible to think of a primary involvement of the trigeminus at least in some peripheral branches.

The main argument for the statement that keratomalacia and xerosis are trophoneurotic lesions most probably caused by central lesions, that is by lesions in the course of ramus ophthalmicus, must be found in the autopsy observations of Cirincione. This argument could be somewhat supported by observations obtained from changes in the nervous system of animals with experimental keratomalacia. The second argument of importance for this theory is the very symptom that Leber regarded as an argument against the theory of a primary lesion in the nervous system in these diseases, i. e., that the disturbance of sensibility is confined to the region of the eyeball and does not involve the other branches of the trigeminus. This localization of diminution of sensibility in the region of the eyeball only is now known as a characteristic symptom of intracranial lesions of the trigeminus nerve (Oppenheim[24]). The same symptom was also reported in disturbances of the ganglion gasseri in several cases, in which it was always complicated by a keratitis neuroparalytica. Sometimes it was observed that the anesthesia localized in the eyeball occurred before the onset of the general anesthesia of the trigeminus, or was the last symptom of a disturbance of the trigeminus to disappear after the healing of the general paralysis of the trigeminus (Dinkler[25] and Heymann[26]). One may therefore assume that the sensible fibers of the trigeminus supplying the eyeball are less resistant or more sensitive than others to various disturbances. Further, from another point of view the fibers of the trigeminus supplying the integuments of the eyeball are different from those supplying the skin and mucous membranes, because, according to Strughold,[27] who

23. Gonzalez, José de Jesus: Die akute Nebenniereninsuffizienz und die Avitaminosen, An. Soc. méx. de oftal. y oto-rino-laring. **7**:33, 1928; Zentralbl. f. d. ges. Ophth. **20**:791, 1928-1929.

24. Oppenheim: Beiträge zur topischen Diagnostik der Gehirnkrankheiten, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **6**:363, 1900.

25. Dinkler: Deutsche Ztschr. f. Nervenh. **1**:371, 1891. Cited in Wilbrand-Saenger: Die Neurologie des Auges, Munich, J. F. Bergmann, 1901, vol. 2, p. 111.

26. Heymann: Neuroparalytische Augenentzuendung, Klin. Monatsbl. f. Augenh., 1863, p. 204.

27. Strughold: Die Sensibilitaet der Horn- und Bindehaut des normalen menschlichen Auges, Zentralbl. f. d. ges. Ophth. **19**:353, 1927-1928.

reported this as the observation of most authors, the former have no sensitivity for pressure but only for pain.

How far the inner parts of the eye are also involved by disturbances in sensibility is difficult to determine. The insensibility of the prolapsed iris in my cases of keratomalacia, as reported, and the insensibility of the resulting leukoma adhaerens cannot be pointed out as characteristic of keratomalacia, because the sensibility in a few other cases of the prolapsed iris caused by other corneal diseases was also found very low, although not as low as that in cases of keratomalacia. That the sensibility in cases of leukoma adhaerens can be diminished permanently has already been pointed out by Krueckmann.[28]

More sensitive to the disturbing factors due to lack of vitamin A than the sensible fibers in the trigeminus are its trophic fibers supplying the cornea and conjunctiva, because the Bitot's spots indicating the first trophic changes in the cornea were present without diminution in sensibility. The diminution in sensibility of the cornea and conjunctiva appeared in these diseases only at a more advanced stage, when the cornea already showed visible changes in the form of prexerosis and xerosis and the conjunctiva more marked changes, such as large xerotic spots, irregularly scattered in the vicinity of the whole limbus, wrinkling and pigmentation. How far the trophic changes affect the intra-ocular parts of the eye is difficult to say, but in two cases of prexerosis Pillat noticed changes of the lens in the form of dustlike opacities in the subepithelial and deepest layer of the anterior cortex, which he thought were most probably not present previously. In this connection should be considered also the report by von Szily and Eckstein [29] on cataract of rat sucklings the mothers of which were fed in the lactation period with vitamin A-free food, although these observations could not be confirmed in experiments performed by Jess [30] and Stepp and Friedenwald.[31] Whether the changes in the retina of patients with Bitot's

28. Krueckmann: Ueber die Sensibilitaet der Hornhaut, Arch. f. Ophth. **41**: 21, 1895.

29. von Szily and Eckstein: Vitaminmangel und Schichstargenese: Katarakte als eine Erscheinungsform der Avitaminose mit Störung des Kalkstoffwechsels bei säugenden Ratten, hervorgerufen durch qualitative Uterernährung der Muttertiere, Klin. Monatsbl. f. Augenh. **71**:545, 1923.

30. Jess, A.: Ueber kongenitale und vererbbare Starformen der weissen Ratte, nebst Bemerkungen über die Frage des Verhaltens der Linsen bei vitaminfreir Ernährung, Klin. Monatsbl. f. Augenh. **75**:48, 1925.

31. Stepp, W., and Friedenwald, J. S.: Zu Frage der experimentellen Erzeugung von Schichstar bei jungen Ratten durch Vitaminmangel der Nährung, Klin. Wchnschr. **3**:2325, 1924.

spots and hemeralopia observed by Uyemura [32] and Fuchs [33] and attributed to vitamin A deficiency could be counted also as trophic changes, it is difficult to affirm. In advanced cases of vitamin A deficiency, moreover, severe trophic changes can be found in the skin and its adnexa and in the mucous membranes and also severe changes in the intestinal and urogenital tracts, as described by several other authors since Leber's first report.

My observations did not include hemeralopia, which is known as one of the beginning symptoms of vitamin A deficiency, but which is not definitely connected with xerosis, as had been pointed out by observers of large epidemics. Cirincione, as previously stated, in the case of his patient with keratomalacia who had suffered during the last three years of her life from hemeralopia found signs of perineuritis of the optic nerve. Verger, Delmas and Lecoulant [34] reported a case of severe hemeralopia, the etiology of which was dubious. The roentgen examination showed a tumor, very likely an osteoma, situated above the lamina cribrosa. The authors thought that this tumor was responsible for disturbances in the nourishment of the optic nerve and the retina. These reports perhaps allow the conclusion that hemeralopia is caused also by lesions in the trunk of the optic nerve.

From a review of the observations reported the conclusion may be reached that the visual changes as well as the sensible changes in the eyes in xerosis and karatomalacia must be due to primary changes in the trophic and sensible fibers of the trigeminus nerve, but at which places in the path of ramus ophthalmicus these changes are localized, it is difficult to state. I am inclined to believe that changes in the ganglion gasseri or ciliare are responsible for the pathologic appearances in the eyeball. It is just as difficult to determine what sort of central changes produce the trophic and sensible disturbances appearing in the integuments of the eye, since up to this moment even the fundamental question about the genesis of these diseases caused by so-called vitamin A deficiency is not yet unanimously agreed on.

SUMMARY

1. Examinations of the sensibility of the cornea and conjuntiva have been made on twenty patients with disturbances of the eye caused by

32. Uyemura, Misao: Ueber eine merkwürdige Augenhintergrundveränderung bei zwei Fällen von idiopathischer Hemeralopie, Klin. Monatsbl. f. Augenh. **81**:471, 1928.

33. Fuchs, Adalbert: Ein Fall von weisspunktiertem Fundus bei Hemeralopie mit Xerose, Klin. Monatsbl. f. Augenh. **81**:849, 1928.

34. Verger; Delmas, and Lecoulant: Un cas d'héméralopie liée à néoformations osseuses de la lame criblée ethmoidale, Rev. de laryng. **49**:267 and 272, 1928: Zentralbl. f. d. ges. Ophth. **21**:63, 1929.

lack of vitamin A; in some cases several examinations have been made at intervals from a few weeks to five months.

2. In the early stage of the disease with Bitot's spots present, but an otherwise normal conjunctiva and cornea, the sensibility of the cornea and conjunctiva has been found practically normal.

3. In all other more advanced stages of this disease with changes of the cornea already visible in the forms of prexerosis and xerosis of the cornea and in advanced xerosis of the conjunctiva, with wrinkling and pigmentation, the sensibility of the cornea has been found diminished to a high degree, sometimes as far as a hundred times below normal, and that of the conjunctiva has also been found diminished but to a relatively low degree, four times below normal at the most.

4. The sensibility of the corneal center is especially diminished in the majority of the cases, being relatively lower than that of the corneal periphery. In some cases the sensibility of the corneal center is even actually less than that of the corneal periphery.

5. The disturbance of corneal and conjunctival sensibility has been found to be present months later, although in a lower degree, while the xerotic disturbances after treatment with vitamin A in the form of cod liver oil have disappeared long since.

6. The involvement of the eye due to lack of vitamin A must be regarded most probably as the result of a centrally situated nutritive and sensible disturbance in which the point of attack is very likely the ganglion gasseri or the ganglion ciliare.

7. The nutritive or sympathetic center of the fibers is more sensitive to the disturbances causing these diseases than the sensible fibers, because the trophic changes in the cornea and conjunctiva start before the sensible changes and disappear more quickly than the sensible changes after the appropriate vitamin treatment has been applied.

8. Hemeralopia, which is one of the characteristic symptoms in the beginning stage of vitamin A deficiency, may be the consequence also of a centrally situated disturbance or of changes in the trunk of the optic nerve.

MICROSCOPIC OBSERVATIONS IN A CASE OF RETINITIS PIGMENTOSA*

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Few eyes affected with retinitis pigmentosa have been examined microscopically. The present case is only the third in which the eye was removed from a living subject, and was therefore free from post-mortem changes, and the second in which the eye was fixed in Zenker's fluid. The eye was removed on account of a tuberculous process in the iris, which fortunately was too recent to have produced any changes in the posterior part of the eye. The tuberculous process will be discussed in a separate communication.

REPORT OF A CASE

History.—Cornelius F., aged 64, was admitted to the Massachusetts Eye and Ear Infirmary on April 1, 1928, complaining that about three days previously he had severe pain in the right eye. His sight began to fail early in life, and he had been blind in both eyes for over twenty years. At the age of 35, he could still read a newspaper. When young, he could not read in a subdued light, and he read fine print more easily than large print. His general health had usually been good. At the age of 27, he had a severe attack of pleurisy, and since then had had a number of minor attacks, an attack eleven years ago being rather severe. The pleurisy was always on the left side.

His parents were not consanguineous. His father died of stricture, and his mother of tumor. A brother and a sister died of tuberculosis. One brother became blind at the age of about 17 years. The patient's wife was alive and well. Two daughters and four sons were alive and had good vision. One child died at birth.

Examination.—The patient was a fairly well preserved old man. No glands were palpable in the neck. Percussion resonance was impaired over the apex of the right lung. Breathing sounds were vesicular except at the right apical region, where they were bronchial to cavernous, with numerous crepitant râles, marked egophony and pectoriloquy. Tactile fremitus was increased. The heart was not enlarged. Second sounds were faint and of fairly good quality. There were no murmurs. The blood pressure was 140 systolic and 80 diastolic. The abdomen was soft, and there was no tenderness. The knee jerks were normal. There was no edema of the ankles. The urine showed a slight trace of albumin, but no sugar. The pulse rate was 81, and the temperature 98.4 F.

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* Read before the American Ophthalmological Society, Hot Springs, Va., June 3, 1930.

* From the Massachusetts Eye and Ear Infirmary.

Roentgen examination of the lungs showed far advanced tuberculosis of the apex of the right lung with cavity formation, a healed area at the apex of the left lung and a ring shadow of the pleura in the left side of the middle part of the chest.

Examination of the right eye showed moderate ciliary congestion. The cornea was clear, the aqueous turbid and the pupil small, irregular and filled with fibrin. The iris was discolored. The fundus was not visible. The tension was 26 mm. of mercury (Schiötz). Vision was absent.

Externally, the left eye was normal. The fundus showed the typical appearance of retinitis pigmentosa. The optic disk presented the waxy appearance characteristic of this disease. There was no cupping, and the lamina cribrosa was not visible. Its outline was distinct. The retinal vessels were small in caliber, even on the disk, and became extremely small at the periphery. No vessels with white borders or that had been converted into white lines were seen anywhere. Around the disk there was little pigmentation of the retina. Branching pigmented figures were fairly numerous at the periphery but scanty elsewhere. They were not often related to the vessels. Fine and coarse pigment granules were seen in areas. In places where there was much pigment, the retina showed a deep-seated gray opacity. Except behind these areas, the choroidal vessels were clearly seen. The vitreous was perfectly clear, showing no opacities even with a + 14 spherical lens in the ophthalmoscope. The lens showed a small, sharply defined posterior cortical cataract, but otherwise it was clear. The tension was 14 mm. of mercury (Schiötz). Vision was absent.

The patient insisted on removal of the right eye on account of pain.

Operation and Course.—On April 2, 1928, simple enucleation of the right eye was done with the patient under local anesthesia. On April 7, he was discharged from the hospital.

On Dec. 30, 1929, the general condition of the patient was unchanged. Roentgen examination of the chest showed identical conditions found on first examination. The temperature was 98 F. The Wassermann reaction was negative. The condition of the left eye was unchanged.

Pathologic Examination of the Right Eye.—The specimen was fixed in Zenker's fluid embedded in celloidin for twenty-four hours. The globe, normal in size and shape, showed nothing macroscopically noteworthy, except pigmentation of the retina as in retinitis pigmentosa. The branching pigmented figures were most numerous in the equatorial region, but were not abundant. Here they occurred at distances of from 0.5 to 2.5 mm. from each other, and the largest would just fit in a circle about 1 mm. in diameter. The retina was everywhere in situ.

Microscopic Examination.—The cornea was normal. The iris showed a recent tuberculous process (described in detail in a separate communication).[1] The vitreous was free from cellular infiltration and showed slight if any increase in its stellate cells. The lens showed a slight posterior cortical cataract—a cleft 0.1 mm. anterior to the posterior capsule, 0.2 by 0.03 mm. in size, in which the lens fibers were breaking up into granules and undergoing solution.

The posterior part of the eye was entirely free from inflammatory reaction. The retina was everywhere greatly altered. No rods remained anywhere, but between the disk and macula there were short stretches, some 1 mm. in width, in which recognizable remains of cones could be seen. The external limiting membrane was intact, the layer of Henle was still recognizable, and the line of synapses was distinct (fig. 1). The cones were about twice as thick as normal,

1. Tr. Sect. Ophth., A. M. A., 1930.

and definitely hexagonal in cross-section. Some of them did not project beyond the limiting membrane, but others sent moundlike projections through its openings. Their nuclei were about one-third larger than normal and situated a short distance internal to the membrane. Elsewhere the external limiting membrane was still recognizable in places, but the neuro-epithelial layer had been replaced more or less completely by neuroglia. The different stages in the formation of the neuroglia were easily observed. Müller's fibers with their nuclei had grown into the layer, often curving around until they ran parallel to the plane of the retina, and finally formed a fibrillated layer between the pigment epithelium and the retina proper (figs. 2 and 3). The nuclei were large and ovoid, sometimes of giant size, and rich in chromatin. The very large nuclei each contained a large vacuole. In places the new Müller's fibers ran through the retina to the external limiting membrane, where they expanded and formed foot plates similar to those found normally at the inner surface of the retina. Where there were remains of cones, the Müller's fibers often ran between the latter up to the membrane. The

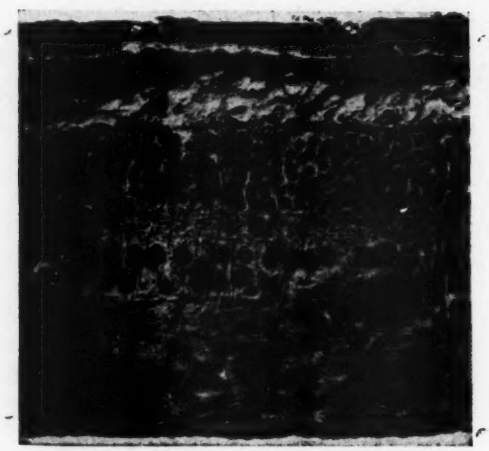

Fig. 1.—Remains of cones and altered pigment epithelium. The retinal ganglion cells are well preserved. Hematoxylin and eosin.

new Müller's fibers stained more intensely in the neuroglia stain than normal fibers, but less so than fully differentiated neuroglia fibrils. The gliosis became progressively more marked from the posterior pole of the eye to the periphery of the retina.

The nuclei of the internal nuclear layer were well preserved, but the layer was often greatly distorted by the large number of new-formed Müller's fibers that had penetrated through it.

The ganglion cells were decreased in number, but not markedly. In places, they occurred in normal number (figs. 1 and 4), but occasionally there were short stretches in which they were scanty (fig. 5). Most of them were normal in appearance. They were least numerous at the periphery, but some could be found as close as 4.5 mm. to the ora serrata. In the macular region, they were abundant.

The nerve fiber layer was of normal thickness. The Müller's fibers running through it were increased in number and thickness. The neuroglia fibrils running in other directions were also abnormally abundant. There was only slight increase in the neuroglia nuclei within the layer.

The hyaloid membrane was in situ. On its inner surface there was in many places a newly formed neuroglia membrane which was sometimes three or four cells thick (fig. 4). Nowhere could it be definitely seen that this membrane communicated with the neuroglia within the retina.

The pigment epithelium was everywhere altered. In stretches, some of them 1.5 mm. long, it was entirely absent, and it was entirely absent for a distance of

Fig. 2.—**Gliosis of the retina. Müller's fibers** extend through the retina and replace the neuro-epithelium with a layer of neuroglia fibrils running parallel with the retina. On the right, the limiting membrane has been destroyed. The normal choriocapillaris of the choroid is well shown. Phosphotungstic acid hematoxylin.

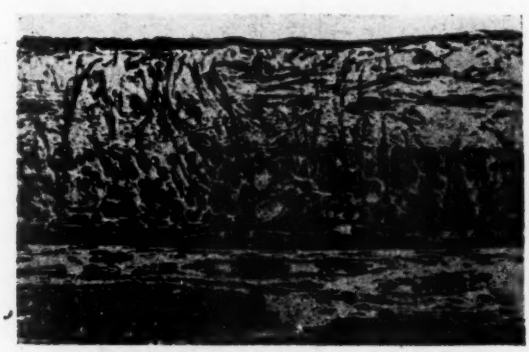

Fig. 3.—Gliosis of the retina. Phosphotungstic acid hematoxylin.

0.5 mm. on each side of the disk. Where it was absent, the neuro-epithelial layer, and even the external limiting membrane, had been completely replaced by neuroglia (fig. 2). Behind the areas in which there were remains of cones, the pigment layer was always present. In some places it retained a close resemblance to its normal morphology. Here it was generally almost free from pigment, although it occasionally retained its pigment, and it showed a fenestrated membrane, and protoplasmic processes. As the pigment layer was followed along, a

stretch might be seen entirely free from pigment, and then abruptly a short stretch of cells densely packed with pigment. In places the epithelium consisted of two layers, the outer layer was sometimes almost free from pigment, while the inner layer was densely packed with pigment. In some places the pigment epithelium was transformed into a layer of spindle cells containing little or no pigment. No fatty granule cells could be seen in the pigment layer or elsewhere in the retina. In some places in which the pigment cells were relatively normal, they were densely packed with pigment granules, all of which had the typical spindle form. In other places, the pigment consisted of small round granules

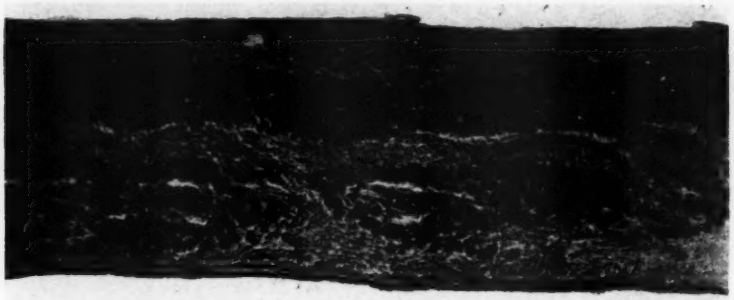

Fig. 4.—Neuro-epithelium replaced by neuroglia. The ganglion cells are well preserved. There is a neuroglia membrane on the inner surface of the hyaloid membrane. Hematoxylin and eosin.

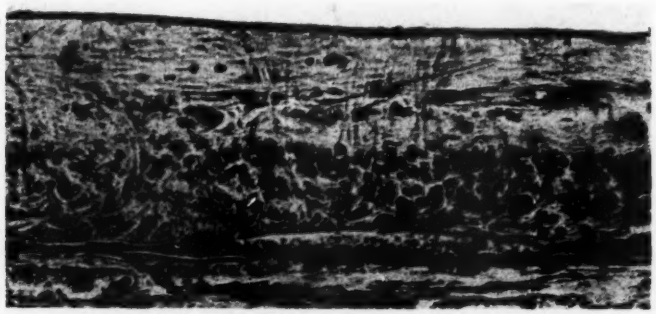

Fig. 5.—Altered pigment epithelium and pigment in inner nuclear layer. On the left, the pigment epithelium has become changed into a layer of spindle cells. The limiting membrane persists, but the neuro-epithelium has been replaced by neuroglia. The retinal ganglion cells are not well shown, but are scanty here. Hematoxylin and eosin.

only. In still other places, the pigment occurred in the form of round balls of various sizes, some as large as a cell. Within these balls, a greater or lesser number of dense pigment granules could be seen. The larger balls seemed to have been formed by coalescence and partial solution of the original finer pigment granules. Pigment, in addition to that around the vessels, was found in the retina proper, almost exclusively in the outer part (fig. 5). However, occasionally

it was seen in the nerve fiber layer. Here it generally consisted of large balls lying free, but sometimes was contained in large round cells about the size of normal pigment epithelial cells, each with an ovoid nucleus lying in contact with the cell membrane. The pigment around the retinal vessels was usually in the form of discrete fine granules, but occasionally it showed changes similar to those seen in the pigment layer.

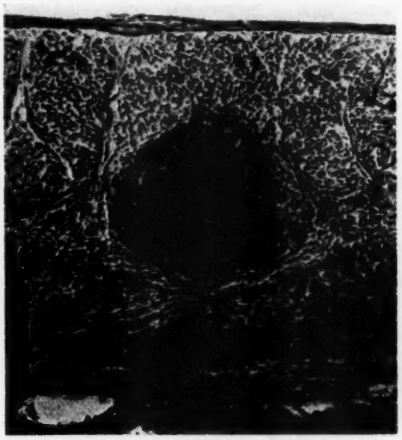

Fig. 6.—Marked thickening of adventitia on one side of retinal vein. Phosphotungstic acid hematoxylin.

Fig. 7.—Flat section of retina showing obliterated hyaline vessel coated with pigment cells. At the curve in the vessel is an area apparently composed of pigment cells which have largely lost their pigment. Hematoxylin and eosin.

The central retinal vessels and their main branches in the disk showed no thickening of their walls and were not obviously reduced in caliber. None of the retinal vessels showed endovasculitis, but as they were followed away from the disk their adventitia became increased in amount (fig. 6). Even vessels of almost capillary size showed an abnormally thick adventitia. At and anterior to the equator, in sections stained in hematoxylin-eosin, very few vessels were recog-

nizable and few vessels containing blood were seen. In sections stained in Mallory's connective tissue stain, however, numerous vessels were seen, but almost all of them had been converted into solid strands of hyaline connective tissue entirely free from cells (fig. 7). Rarely, a minute empty lumen could be recognized in the center of a strand. Even vessels of capillary size had thus been

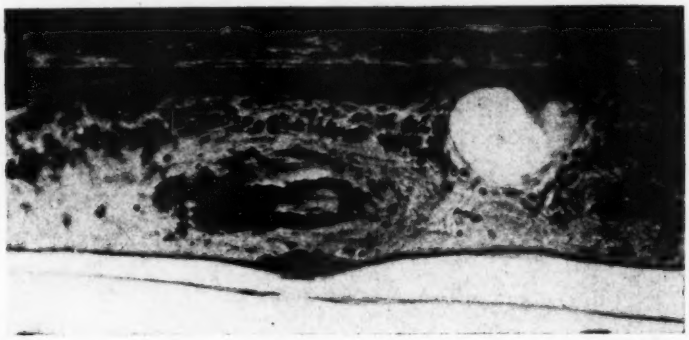

Fig. 8.—Altered pigment epithelium and pigment around obliterated vessels. The small cyst has been formed by infolding of the neuro-epithelium, and is lined by the original external limiting membrane. There is a small nodule of neuroglia cells beneath the hyaloid membrane. A delicate neuroglia membrane has been artificially separated from the hyaloid membrane. Hematoxylin and eosin.

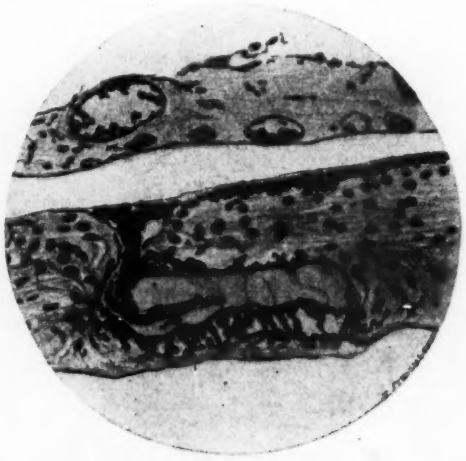

Fig. 9.—Drawing, showing pigment epithelium proliferating inward and surrounding a vessel. Hematoxylin and eosin.

transformed. About the vessels, the neuroglia had proliferated and formed long thick neuroglia fibrils which followed along the vessels. These were best seen in flat sections of the retina. Sections stained in Verhoeff's elastic tissue stain showed no proliferation of elastic tissue in the walls of the retinal vessels. Posterior to the equator, none of the larger vessels and few if any of the smaller vessels were obliterated.

The sections stained in connective tissue stain showed here and there small vessels penetrating the external limiting membrane and extending between the pigment layer and the retina. In places, delicate connective tissue fibrils, no doubt derived from the vessels, could be seen between the pigment layer and retina, and sometimes also between the pigment layer and Bruch's membrane. These vessels and connective tissue fibrils were not recognizable in sections stained in hematoxylin and eosin.

In the fundus, few vessels surrounded by pigment were seen, but in the equatorial region and beyond, there were many such vessels (figs. 8 and 9). Almost all of these vessels had been converted into solid hyaline strands (fig. 7). The pigment cells around them sometimes consisted of discrete round cells, densely packed with pigment; sometimes the cells took the form of a continuous epithelial layer. In several instances, this epithelium could be traced into continuity with the original pigment epithelium (fig. 9).

Near the ora serrata, the retina showed cystoid degeneration of moderate degree, entirely similar to that observed in senile eyes. In the retina elsewhere,

Fig. 10.—The optic nerve and disk appear normal, except for a delicate neuroglia membrane extending over the surface of the disk. The membrane is artificially separate. Hematoxylin and eosin.

even in the fundus, small cysts of a different nature were occasionally seen (fig. 8). These were always in the outer part, and the largest was about half the thickness of the retina. They were lined by a membrane and contained serum. Various stages in their formation could be observed, and it was seen that they were due to infolding of the external limiting membrane and altered neuro-epithelium resulting from contraction of the newly formed neuroglia.

The optic disk showed a delicate neurogliar membrane extending over its surface, which was continuous with the similar membrane on the surface of the retina already described. Otherwise, in sections stained in hematoxylin and eosin, the disk and nerve stem appeared normal (fig. 10). They showed no obvious increase in neuroglia nuclei. The neuroglia stain, however, showed definitely an increased amount of neuroglia in the disk, especially near its surface. The neuroglia fibers were not only increased in number, but were abnormally coarse. The myelin sheath stain showed no atrophy in the nerve stem.

The choroid, including the membrane of Bruch and the choriocapillaris, was normal with the exception that some of its arteries showed endarteritis. This was no greater than would be expected at the age of 64 years. The membrane of Bruch showed slight basophilic staining in places, but this is normal in senile eyes.

COMMENT

The most complete critical analysis of the literature relating to retinitis pigmentosa is that of Leber,[2] who refers in his discussion also to many of his own observations. With the exception of the communications of Collins,[3] Takahashi [4] and Sugita,[5] I have been unable to find anything of noteworthy importance in the subsequent literature. Leber concluded that the essential retinal lesion in the disease was degeneration of the neuro-epithelium, the rods being the first affected, and that as a result of this degeneration there occurred degenerative and proliferative changes in the pigment epithelium with migration of the pigment cells into the retina, growth of pigment cells around the vessels, replacement of the neuro-epithelium by neuroglia, hyaline change and obliteration of the vessels at the retinal periphery, and atrophy of the ganglion cells and optic nerve. He concluded also that the choroid, including the choriocapillaris, was not concerned in the process. These conclusions were based chiefly on the microscopic changes observed by Gonin,[6] Stock,[7] Ginsberg [8] and Suganuma.[9]

The microscopic changes in my case confirm these conclusions, except in regard to the ganglion cells and the optic nerve. Since this was a typical case in a far advanced stage, the condition of the choriocapillaris in it was of great significance. Fortunately, the eye was fixed in Zenker's fluid, which caused little if any shrinkage of the choroid—in eyes fixed in formaldehyde the shrinkage is often so great that the choriocapillaris cannot be recognized. The choriocapillaris was normal, and the remainder of the choroid was also normal with the exception of some of the arteries which showed senile endarteritis in moderate degree. It is obvious, therefore, that obliteration of the choriocapillaris or choroidal circulation can be dismissed as a possible cause of a retinitis pigmentosa. My observations also accord with the view that the rods are the elements first affected, since they were entirely gone,

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2. Leber, in von Graefe-Saemisch: Handbuch der gesamten Augenheilkunde, Leipzig, W. Engelmann, 1915, vol. 7, p. 1076.
3. Collins: Tr. Internat. Cong. Ophth., Washington, 1922, p. 103.
4. Takahashi: Arch. f. Ophth. **116**:143, 1925.
5. Sugita: Arch. f. Ophth. **116**:653, 1926.
6. Gonin: Ann. d'ocul. **129**:24, 1903.
7. Stock: Klin. Monatsbl. f. Augenh. **46**:225, 1908.
8. Ginsberg: Klin. Monatsbl. f. Augenh. **46**:1, 1908.
9. Suganuma: Klin. Monatsbl. f. Augenh. **50**:178, 1912.

whereas there were remains of cones in places. The rods and cones are commonly thought of as the small structures lying outside the external limiting membrane. Degeneration of these alone would not seem to be sufficient to affect the rest of the retina greatly. As a matter of fact, each rod and each cone passes through an opening in the external limiting membrane and continues as a fiber, the fibers forming the layer of Henle, and their nuclei the external nuclear layer. All the elements together constitute the neuro-epithelial layer, and this makes up about one-third the thickness of the retina. Obviously, degeneration of this layer would produce profound changes in the whole retina. There can be no doubt, therefore, that the gliosis of the retina, and probably also the changes in the pigment epithelium, are due to this cause. The supposition of Collins that migration of pigment cells into the retina is due to the effect of light rays is unnecessary. In fact, there is no evidence that in man light has an effect on the pigment epithelium such as it has in the case of some of the lower animals.

Since pigmentation of the retina is the most conspicuous ophthalmoscopic feature of the disease, it has been thought that the primary change is degeneration of the pigment epithelium. Simple degeneration of this epithelium, however, does not lead to the other changes associated with retinitis pigmentosa. I have examined an eye in which the pigment epithelium showed wide areas of complete senile degeneration and partial calcification, without having produced pigmentation of the retina or degeneration of the rods or cones. The possibility is not excluded, however, that in retinitis pigmentosa the changes in the pigment epithelium are partly or wholly due directly to the same cause that leads to the degeneration of the neuro-epithelium.

In spite of the eye having been blind for twenty years, the retinal ganglion cells were still abundant, the nerve fiber layer of normal thickness, and the optic disk and nerve apparently normal. Even the myelin sheath stain failed to show any atrophy of the optic nerve. This is not in accord with Leber's statement, although he does qualify it by saying that in some cases the process ceases so that after many years the myelin sheaths are not quite lost. Stock,[7] in two cases of the congenital type of the disease, in which he examined the eyes post mortem, found no atrophy of the optic nerves and concluded that absence of such atrophy constituted an essential difference between this and the ordinary type. Ginsberg,[8] however, in his case of the ordinary type, found no optic atrophy, so that his case with mine show that Stock's conclusion was incorrect. Why the optic nerve should show more or less marked atrophy in some cases and none in others is not clear. The atrophy of the nerve fibers is evidently dependent on degeneration of the ganglion cells. Since the ganglion cells are not directly connected with the rods and cones, degeneration of the latter would not necessarily injure them.

Probably whatever injury the ganglion cells sustain results from the gliosis and vascular changes, but why it should be greater in some cases than others, I am unable to explain. In my case there was sufficient loss of ganglion cells to cause considerable total reduction in nerve fibers, but no doubt the affected fibers were so completely degenerated and so greatly scattered throughout the nerve as not to be recognizable. The waxy appearance of the optic disk, which is such a characteristic ophthalmoscopic feature of the disease, is evidently not due to degeneration of nerve fibers, but probably, as assumed by Collins, to an increased amount of neuroglia in the disk. In my case the gliosis here was not marked and was evidently an extension of the retinal gliosis. The histologic features of my case, not noted in previous cases, and revealed by special staining, were the formation by some of the newly-formed Müller's fibers of foot plates beneath the external limiting membrane similar to those at the inner surface of the retina, the occasional continuation of small vessels through the outer surface of the retina, and, in some instances, between the pigment epithelium and Bruch's membrane, and the formation of small cysts by the infolding of the external limiting membrane as result of the retinal gliosis.

A characteristic ophthalmoscopic feature of retinitis pigmentosa is reduction in the calibre of retinal vessels. According to Collins the vessels of both the retina and the choroid "dwindle." Just how degeneration of the neuro-epithelium could cause dwindling of these vessels, as he further stated, is not clear to me. As a matter of fact, the choroidal vessels, as already pointed out, are not affected. Judging by the changes in my case, the retinal vessels do not dwindle, but their lumina become narrowed as a result of the thickening of their walls by connective tissue. This tissue evidently has about the same index of refraction as the contiguous retinal tissue, since usually it is not ophthalmoscopically visible. It is apparently not produced by the intima, but by the adventitia of the vessels.

While in my case the main branches of the central vessels showed microscopically no obvious reduction in calibre, judging ophthalmoscopically by the other eye, they would have appeared definitely smaller than normal. Probably their walls were actually abnormally resistant, so that during life they were less distended than normal vessels.

Leber suggested that the narrowing of the larger vessels is due to the marked changes in the smaller vessels and capillaries at the periphery. Obstruction to the latter vessels, however, it seems to me, would cause dilatation of the larger vessels, at least the arteries, unless their walls had become thickened. He also suggested that the hyaline transformation of the smaller vessels is due to the formation of a cuticular substance by the pigment cells that surround them. In my case, the vast majority of the vessels that showed hyaline transformation

were not surrounded by pigment cells. This was obvious, however, only in sections stained in Mallory's connective tissue stain. In sections stained in hematoxylin and eosin, the hyaline vessels were so inconspicuous that they could scarcely be recognized unless surrounded by pigment.

The retinal changes cannot be due to the vascular changes, because still greater obstruction of the retinal circulation, even complete obstruction of the central retinal artery, such as sometimes occur in cases of arteriosclerosis, does not lead to degeneration of the neuro-epithelium. It is obvious, therefore, that the vascular changes are dependent on the degeneration of the neuro-epithelium. The connective tissue in the walls of the vessels undergoes hyperplasia, just as does the retinal glia tissue. The lumina of the smaller vessels finally become so constricted that the walls perhaps suffer from lack of nutrition and as a result undergo hyaline degeneration. This change is not visible with the ophthalmoscope because of the transparency of the hyaline substance. For this reason, as pointed out by Leber, the fact that the branching pigmented figures are always related to blood vessels is also often not recognizable.

Nettleship (cited by Leber [2]) ophthalmoscopically observed pigmentation only around retinal veins, never around arteries. In my case, the pigmented vessels were so greatly altered that I could not determine microscopically whether they were veins or arteries. In cases of intraocular tuberculosis, however, I have noted that macrophages entering the retina from the vitreous accumulate and form tubercles almost if not exclusively around the veins. It is evident, therefore, that ameboid cells are attracted to veins, a fact that is in accord with Nettleship's clinical observations.

Posterior cortical cataract is another characteristic feature of the disease. It occurs late, and is certainly due to the disease, but probably not to the original cause of the disease. It seems impossible that slow degeneration of the retinal epithelium could produce sufficient toxic substances in the vitreous to injure the lens. More likely the injury to the latter is due to an accumulation of deleterious substances in the vitreous as a result of the impairment of the retinal circulation. The same sort of cataract occurs in old cases of marked syphilitic chorioretinitis, separation of the retina and other fundus conditions, in which no doubt it is due to disturbed nutrition of the lens.

Another complication that occurs in cases of retinitis pigmentosa too often to be simply coincidental is glaucoma. This also may be due to the impaired retinal circulation, as in cases of glaucoma secondary to obstruction of the central retinal artery.

Admitting now that degeneration of the retinal neuro-epithelium is the primary lesion in retinitis pigmentosa, what is the cause of this

degeneration? The facts that the disease is undoubtedly hereditary, that it is often associated with deafness and with congenital anomalies and sometimes with cerebral degeneration have not thus far led to a solution of the problem.

Leber [2] favored the view that the effect of light in association with diminished resistance of the neuro-epithelium, especially of the rods, is responsible for the degeneration. He pointed out that in congenital night blindness, the rods are easily fatigued by light, and assumed that retinitis pigmentosa is simply a more marked condition in which the rods are actually injured by light. Collins [3] has advanced the view that the degeneration is due to "abiotrophy." The latter is a term introduced by Gowers, which, it seems to me, means nothing more than premature senility of specified tissues. Many of the cells of the body seem to be capable of proliferation indefinitely, some of them even in vitro, while others have in adult life lost the power completely. According to Gowers, the latter cells will die in a certain time which differs in different cases, no matter how favorable their environment may be. Collins pointed out that the rods and cones belong to this class, and that in certain persons they die early in life, thus explaining retinitis pigmentosa. In connection with Collins' theory, the breeding experiments of Keeler [10] may be of significance. He found that in certain blind white mice, the retinal neuro-epithelium was absent or rudimentary and that the condition was a mendelian recessive character. It could be recognized on the thirteenth day after birth, but not before this, because the retinal layers were not sufficiently differentiated. Since the neuro-epithelium may thus, as the result of hereditary influences, entirely fail to develop, it is reasonable to believe that in certain cases it may develop but lack normal vitality, as assumed by Collins.

Leber admitted that no satisfactory explanation of the ring scotoma in early cases of retinitis pigmentosa has been advanced. He attempts to explain it, however, by the facts that the rods are more abundant at the periphery, the nourishment of the neuro-epithelium by the choriocapillaris is richer in the macula than elsewhere, and that relatively little light reaches the extreme periphery of the retina. He stated that it is well known that the retina can be injured by sunlight. It is true that the macula can be injured by the concentrated rays of the sun, as in eclipse blindness, but this is an effect of the heat produced. Experiments by Bell and myself on the human eye and on the eyes of animals show conclusively that the normal retina cannot be injured by any light that can pass through the lens, if the intensity is insufficient to produce a heat effect. For this reason, the theory that exposure to light is an essential cause of retinitis pigmentosa seems highly improbable, to say the least.

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10. Keeler, C. E.: Proc. Nat. Acad. Sc. **10**:329, 1924; **12**:255, 1926.

Collins' theory of abiotrophy as an explanation of the disease cannot at present be proved or disproved, but it seems to explain all the facts well. Collins explains the ring scotoma by assuming that "the part of the retina in which failure of function commences is that in which its neuro-epithelium first attains its full development." His theory, however, will always be open to doubt so long as the possibility remains that the degeneration of the neuro-epithelium is due to some toxic influence. Moreover, Collins' theory so completely excludes any hope of combatting the condition by therapy, that every endeavor should be made to disprove it and to discover a different cause.

As a matter of fact, the theory that the condition is due to some toxic influence acting through the blood or vitreous, explains the known facts as well as Collins' theory. As Leber pointed out, in some cases of old syphilitic chorioretinitis, the retinal changes are almost identical with those in primary retinitis pigmentosa, and there may be no alteration in the choriocapillaris. I have found that here, too, the pigmentary changes are most marked at the equator and that the cones persist longer than the rods. In such cases the degeneration of the neuro-epithelium is unquestionably due to local toxic influences. In certain cases of leukoma adherens, without glaucoma, as Leber also pointed out, the retina shows typical retinitis pigmentosa. Here the toxic influence must be in the vitreous, probably due to relative stagnation of the intraocular fluid. Similar retinal changes may also sometimes occur in cases in which a cataractous lens has remained dislocated in the vitreous for a long period of time. In connection with possible toxic influences, Leber called attention to the experiments of Capauner, who obtained pigmentary degeneration in the retina of rabbits by injecting papayotin into the vitreous, to the experiments of Schreiber and Wengler, who injected scharlach oil into the anterior chamber, and to the experiments of Igersheimer, who injected sodium arsanilate subcutaneously into rats and into the vitreous in rabbits, with resulting injury chiefly to the neuro-epithelium.

It is certain, therefore, that toxic influences acting either directly through the blood or indirectly through the vitreous could act electively on the retinal neuro-epithelium, and even electively on the rods. Conceivably, they might also affect the inner ear and cerebrum. The reason the rods are more vulnerable than the cones may be simply because of their smaller size. It is possible that we have a clue to the existence and nature of such a toxic influence in the well known fact that in certain cases of disease of the liver, notably hypertrophic cirrhosis, there is night blindness. The latter is not related to the jaundice which may accompany the condition, but this fact does not exclude the possibility that it is due to an excess in the blood of bile salts or other substances derived from the liver, and that these may affect the visual purple and

the rods in which this substance is supposed to reside. A hereditary disturbance of liver function, existing for a long period of time, therefore, might well cause degeneration of the retinal neuro-epithelium.

In this connection, the experimental work of Sugita [5] is possibly of some importance. He found that the injection of bile or some of its constituents into rats produced hyperemia of the choroid, "cholesteatose" in the pigment epithelium, and partial degeneration of the outer retinal layers. The pigment cells proliferated and then migrated inward as fatty granule cells. In some instances, the pigment epithelium showed "cholesteatose" without the retina being affected. Sugita also found that bile could dissolve visual purple. He believed that his experiments explained the hemeralopia of avitaminosis, but did not suggest that they were of significance in regard to congenital hemeralopia and retinitis pigmentosa. It seems to me, however, that in this regard they are of possible significance to the extent that they show that the pigment epithelium and the neuro-epithelium of the retina can be injured by certain constituents of bile acting through the blood. The effects in his experiments were too rapidly produced to be comparable to the changes found in retinitis pigmentosa. Moreover, in my case at least, the pigment cells did not contain lipoid granules.

Perhaps of greater significance in regard to retinitis pigmentosa is the investigation of Takahashi.[4] By a variety of methods, he investigated the hepatic function in twelve cases, and found it abnormal in each. If further investigations confirm these results, they may lead to the discovery of some means of checking the progress of the disease.

SUMMARY AND CONCLUSIONS

A man, aged 64, blind in both eyes for over twenty years, developed acute tuberculous iritis in the right eye. The left eye showed the typical ophthalmoscopic picture of retinitis pigmentosa. On account of pain, the right eye was removed five days after the onset of symptoms. The fundus of the right eye was entirely unaffected by the tuberculous process. The histologic changes found are described and the following conclusions drawn:

The essential ocular lesion in retinitis pigmentosa is progressive degeneration of the retinal neuro-epithelium, the rods being first affected.

The changes affecting the pigment epithelium probably result from the degeneration of the neuro-epithelium, but the possibility that they are due to the same cause that leads to the degeneration of the neuro-epithelium has not been excluded.

The reduction in calibre of the retinal vessels is due to increased thickness of the adventitia. The thickened adventitia is usually too transparent to be visible ophthalmoscopically.

The optic nerve may show little if any atrophy even in an eye blind for many years from retinitis pigmentosa. The waxy appearance of the disk seen with the ophthalmoscope is due to gliosis.

The posterior cortical cataract is due to disturbed nutrition of the lens resulting from the impaired circulation of blood in the retina. Secondary glaucoma, which sometimes occurs, is probably also dependent on the impairment of this circulation.

Retinitis pigmentosa is not due to vascular or other changes in the choroid.

The theory of abiotrophy as a cause of the disease explains all the facts well, but should not be accepted until other possibilities have been excluded.

The theory that light is a factor in the causation of the disease is highly improbable.

The theory that the disease is due to disturbance of the hepatic function is worthy of serious consideration, but requires additional evidence to support it.

HEREDITARY OPTIC ATROPHY (LEBER'S DISEASE)

A CLINICOSURGICAL STUDY OF A CASE *

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When ophthalmology veers into the sphere of neurology, the complaint is "My sight is failing," as Cushing stated in his syndrome on atrophy of the primary nerve and intracranial neurosurgical conditions. And, as he likewise stated, it is often the sole complaint.

When every lead has been followed and every clue exhausted, there still remains a group of cases in which there is nothing but failure of vision and indefinite optic neuritis, the etiologic factor defying discovery. From this group one can isolate those cases in which there is a definite familial history and a regularly recurring syndrome of "rapid onset of blindness affecting both eyes to different degrees and not simultaneously, with central scotoma, slight if any concentric contraction and fleeting disk findings of a mild neuritis followed by secondary pallor." This definitely outlined condition has been designated as Leber's disease, since he first described it in 1871. Various authors have stretched this specific deliniation to include secondary atrophies in which neurologic changes are associated, as Ferguson and Critchley,[1] who sought to establish a relationship between Leber's disease and various heredofamilial ataxias, a relationship that Leber definitely excluded from the beginning.

An attempt to analyze the puzzling factors of this seemingly distinct entity leads one to ask various questions: Why are specific fibers involved? Why are both nerves involved? Why is the age limited more or less definitely? What is the basis of the almost mendelian inheritance? What stops the progress so that absolute blindness is rare? etc., ad infinitum.

Hogg [2] made these same observations in a study on sixteen cases, but he arrived at no conclusion other than that the deformity of the sella turcica was too variable to be included as characteristic.

In studying the case which is reported here, my attention was continuously being focused and refocused on the chiasmal region—the

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1. Ferguson and Critchley: Leber's Optic Atrophy and Relationship to Heredofamilial Ataxias, J. Neurol. & Psychopath. **9**:120, 1928.

2. Hogg, S. H.: Hereditary Optic Nerve Atrophy, Eye, Ear, Nose & Throat Monthly **7**:193, 1928.

bilateral nature of the process, the tendency to a bitemporal swing to the scotomas, the small closed over sella turcica in the patient and in his brother, the total absence of any discoverable systemic basis, glandular or infectious, and the mechanical factors involved.

In spite of the fact that Traquair's picture of an optic neuritis affecting the chiasma—with its frequent headaches, wandering scotoma, pain and recovery—directly bore no resemblance whatsoever to my case, I still felt that whatever the pathologic process was it must be located in that region. With this thought in mind and the utter inadequacy of all known methods of treatment, I felt justified in the procedure outlined. My case was so devoid of all neurologic symptoms or those of any disturbed glandular balance that from the beginning I ruled out the possibility of a disorder of the pituitary gland, in spite of the analysis of Fisher,[3] in 1916, whose cases did seem to bear a possible connection with a hypophyseal pathologic process.

In 1912, Cushing did a decompression in a case of Leber's disease and found an edematous brain with an excess of fluid. He did not see the structures at the base of the brain. In his case, there was no improvement.

I conferred with a brain surgeon of Chicago about an exploratory operation in the case to be reported and he spoke of a small series of cases of undiagnosed sudden blindness that he had had in which he did an intracranial operation and found a pathologic process at the base of the brain in the form of an arachnoidal change. (This paper is being prepared for publication by Dr. Davis and Dr. Haven.) These patients showed definite improvement in vision.

At the same time I wrote to various brain surgeons throughout the country, and found them quite undecided as to the nature of an arachnoiditis in the chiasmal region, or its relationship to familial types of visual disturbance. Dr. Heuer stated:

> I believe that there are many conditions about the optic chiasm outside of hypophyseal tumors which may cause disturbances in vision in which ophthalmologic examination shows a primary optic atrophy and in which perimetric examination shows more or less definite hemianopia. Among these conditions, I am sure that an arachnoiditis is one, and I have myself operated in three cases in which the only condition found on exploring the region of the optic chiasm has been adhesions and an excessive amount of cerebrospinal fluid about the chiasm. Following the separation of the adhesions and the escape of the cerebrospinal fluid, there has been in all three cases a striking improvement in vision with a disappearance of the hemianopia.

With an unexplained pathologic process suspected in the chiasmal region and no known procedure to follow that has helped in cases of Leber's disease, I still felt justified in advising an exposure of this

3. Fisher, J. H.: Leber's Disease, Tr. Ophth. Soc. U. Kingdom **36**:299, 1916.

area in my case. As there was a little encouragement and some hope, the patient wanted to take the chance.

REPORT OF CASE

History.—Edward, aged 25, an auditor, single, about four weeks previous to consulting me, suddenly began to lose vision in his left eye, which had been normal up to that time. An oculist fitted him with glasses, which gave no improvement. Shortly after this, the vision of the right eye began to fail, and at this stage, he came to me.

There was no history of injury or illness. The patient did not drink or smoke, and had not been taking drugs of any kind. About three years before he had done clerical work in a paint shop for seven months, but had never handled paint. He had been in perfect health, with no nasal or postnasal discharge, no pain or headaches, no sore throat and no history of venereal infection.

On inquiry into the family history, it was discovered that an older brother, aged 29, had an exactly similar experience about five years before, when, while driving a car, he discovered that vision in one eye had begun to fail rapidly. He had been given "treatments" for over a year, with no response, and his vision had steadily declined, until he saw just enough to get around. He was subject to severe headaches and a decidedly excitable mental phase at the time of the headaches. Both were seemingly controlled by hypodermic injections of strychnine. Two uncles on the maternal side had also become blind rather abruptly, and there was an indistinct history of eye trouble further back in the maternal pedigree. An older brother, aged 31, had had no trouble, and a sister also had never had any visual defect.

Examination.—The patient was physically normal, except for the condition of the eye, with no signs of hypopituitary or hyperpituitary function. There were no neurologic signs, no ataxia, no speech defect and no emotional instability. His eyes externally were normal as to color, extra-ocular movements and pupillary reactions. Vision in the right eye was 20/100; the left eye could see fingers at 12 inches. With the use of a cycloplegic, the fundus was examined. The lens and media of the right eye were clear. The disk was rather red and angry-looking, with a fine exudate covering the upper temporal edge. The lamina cribrosa was not visible, and the cupping was normal in depth and diameter. The veins, especially in the upper half, were markedly congested and swollen; the arteries everywhere were narrow. The macular region was apparently normal; there were no edema, no pigment change and no visible degenerative signs. The peripheral fundus revealed no abnormalities.

The lens and media of the left eye were clear. The upper temporal quadrant of the disk was slightly blurred, and from its lower margin started a narrow pigment ring which edged the temporal side of the disk. The lower temporal quadrant was distinctly pale, suggesting a beginning atrophy. The lamina cribrosa was not visible, although there was no exudate in this eye. There were no abnormalities of the vessels of this eye, and here also the macular region and periphery evidenced no visible change.

The visual field of the right eye showed a slight uniform concentric contraction with a decided contraction of the red color field and an indistinct discrimination of colors in the central field of vision, which was more marked in the temporal half of the field.

The visual field of the left eye showed a slight concentric contraction of the full field with an absolute central scotoma of 10 degrees for 2 mm., white (the fixation point was not seen at all). There was a relative scotoma for red ranging about 25 degrees in the temporal half of the field and about 10 degrees in the nasal half, with a decidedly hemianopic outline. Intra-ocular tension (Schiötz) was 20 in both eyes. The Wassermann reactions of the blood and spinal fluid were negative; the cell count was 50; white blood cells, 9,300; red blood cells, 5,300,000. The systolic blood pressure was 120 and the diastolic 60. The urine was negative for albumin and sugar, with few uric acid crystals. A roentgenogram of the skull revealed a decidedly small sella turcica, which seemed to be partially bridged over by a calcified continuation of the clinoid process.

The brother Charles was also examined. The results of the physical examination were negative. The external eye was normal. The fundus showed a full-fledged secondary optic atrophy which was more advanced in the left eye than in the right. There were no signs of congestion and no macular changes. The vitreous and lens were clear. The visual field showed a slight bilateral

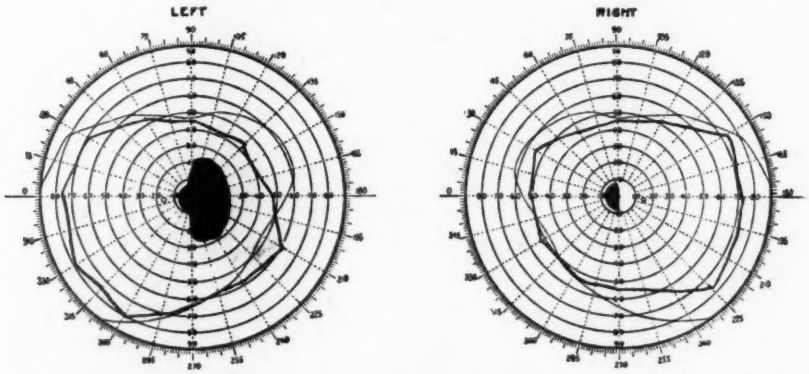

Fig. 1.—Visual fields on Feb. 4, 1930, before operation. In the right eye vision was 20/100, and in the left eye, it was limited to perception of fingers at 12 inches. In the left eye there was absolute scotoma for 2 mm., white, and in the right eye, relative scotoma for 2 mm., red.

contraction with a relative central scotoma for 2 mm., red and green in both eyes, ranging about 30 degrees in the left and 20 degrees in the right, with no tendency toward greater fulness in the temporal half. Unlike his brother, he was able to see the white fixation point with both eyes. Repeated Wassermann tests were negative. A roentgenogram of the hypophysis also showed a small sella turcica.

Treatment and Course.—Seven days after the patient was first seen, vision decreased from 20/100 to 20/200. In view of the seeming association of this disease with some abnormality in pituitary function, I thought at first of giving him large doses of a hypodermic preparation of anterior pituitary lobe as there was a possibility of a hyposecretion and a compensatory hyperplasia with pressure. But realizing the dubious value of glandular assays and seeing vision decidedly fail, I felt that this was leading nowhere, so the patient was frankly told that an exploratory operation on the brain might reveal some pathologic process that might be remedied, but that there was no way of telling in advance what would be found or done, or what the result would be. He consented to the operation

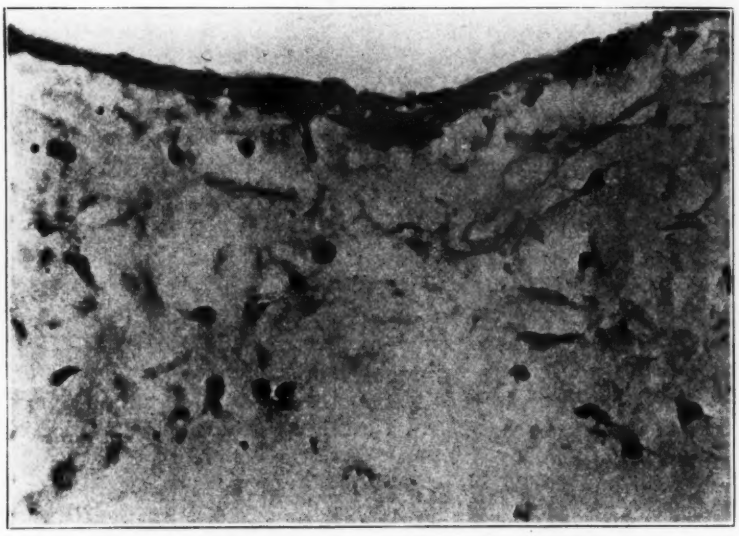

Fig. 2.—Photomicrograph of arachnoid tissue.

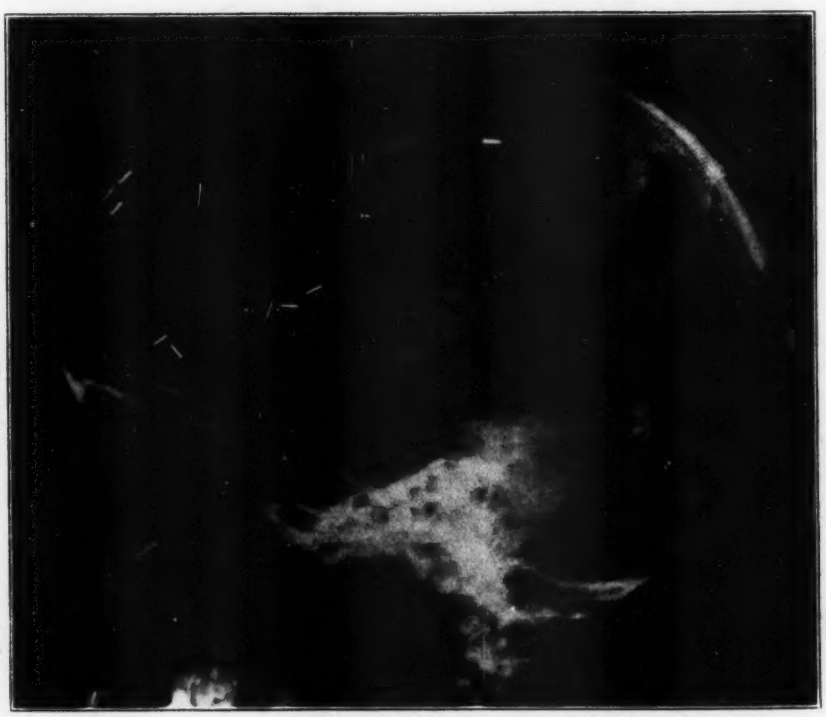

Fig. 3.—Ventriculogram showing normal lateral ventricle.

and the following is the surgical report by Dr. L. Davis of Chicago: "After the administration of ½ grain (32 mg.) of morphine sulphate and 1/150 grain (0.4 mg.) of atropine sulphate, I infiltrated the scalp of the right frontal area with procaine hydrochloride and outlined the right frontal osteoplastic flap. No particular difficulty was encountered except near the median line, where the dura mater was particularly adherent to the inner surface of the bone and tore as the Gigli saw guides were passed. There was some venous bleeding, which was controlled, however.

Fig. 4.—Ventriculogram showing the third ventricle normally filled with air.

"The flap was turned down, exposing a normal appearing dura mater which was not under tension. It was opened with the base of the flap near the median line. The cortex was not under tension, and the gyri were normal in outline. The vessels of the cortex were normal. The arachnoid and pia were not thickened, and there was no large amount of cerebral subarachnoid fluid. I introduced a cannula into the right lateral ventricle, which was entered at a normal depth. Clear cerebrospinal fluid was removed. It was not under tension. The frontal lobe was retracted without difficulty, and the optic chiasm was exposed. The right optic nerve was not enlarged, nor was it injected. There were a few arachnoidal adhesions to the nerve, one of which was removed for section. The chiasm appeared quite normal. The left nerve was similarly normal in size and

was not injected. It was adherent, however, to the under surface of the frontal lobe, but was separated from it without difficulty. The pituitary gland was normal in color and size, and no part of the sella impinged on the chiasm. I felt that this was not the picture encountered in cases like those of Holmes, Gerlach, and others, who found a large collection of fluid about the chiasm, and the arachnoid about the chiasm thickened. I did empty some fluid from about the chiasm, but not a particularly large amount."

The following pathologic report is given by Dr. Haven: "The small piece of arachnoid membrane removed at operation was fixed in formaldehyde, embedded in paraffin, cut in cross-section and stained with hematoxylin-eosin. These

Fig. 5.—Encephalogram showing air in the interpeduncular cistern.

sections revealed the normal flattened arachnoid cells on the surface with a marked thickening of the reticular structure due to an increase in the fibrous elements. There was a moderate amount of leukocytic infiltration into this reticular area."

Reexamination.—On March 1, one month after the first examination, the patient seemed rather worn out and nervous from too much fuss and attention given him at the industrial plant, where he had worked for twelve years and had been much beloved, so he was sent to the country for a month's rest. A rough check of his condition before leaving are as follows: Vision in the right eye was 20/100; in the left eye, 2/200. There seemed to be little if any change in the fundus unless perhaps the congestion of the right eye was slightly less. The nasal half of the visual field in the bad eye had returned, as he saw 1 mm. fixation light.

On March 13, 1930, one month after operation, the vision in the right eye was 20/60, and in the left eye 4/200. The patient saw 1 mm. fixation light in full field. He tired easily. There was no change in the fundus. The patient's general condition was good, and the incision scar was disappearing. The patient was back at work.

On March 17, vision in the right eye was 20/50 and in the left 9/200.

On May 7, vision in the right eye was 20/50 and in the left, 9/200, apparently stationary.

On July 28, after several months of improvement, which made me hope that the mysterious process associated with the progressive destruction of the optic nerve fibers had been halted, the vision in the good right eye began to be further impaired, the vision in the left eye remaining stationary. Vision in the right eye was 20/200 and in the left 9/200. At this time it was felt that rather than subject the patient to intracranial exploration, air should be injected into the ventricles, as any possible silent tumor mass or any newly formed chiasmal adhesions would

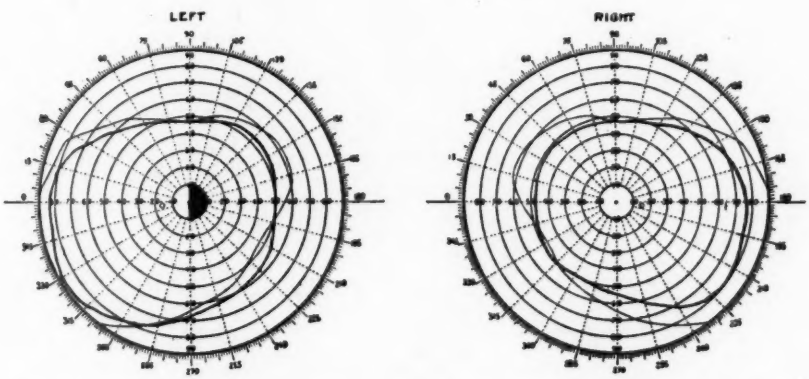

Fig. 6.—Visual fields on March 1, 1930, two weeks after operation. In the left eye there was absolute scotoma for 2 mm., white, in the nasal half of the field. Vision was 20/100 in the right eye and 2/100 in the left.

thus be outlined. Dr. Percival Bailey carried out this procedure, and gave the following interpretation:

"The spinal canal was completely drained, 126 cc. of fluid in all being removed. The x-ray examination showed that the air had filled the interpeduncular and posterior space, and that there was considerable air over the surface of the brain. However, this air did not outline the sulci as distinctly as is usually the case, and none of it had entered the ventricles.

"This is the first time in my experience that the air in an encephalogram has not entered the ventricles in the absence of an obstruction to the aqueduct of Sylvius. It was thought that possibly there were some adhesions around the fourth ventricle, which had blocked off the usual foramen of Luschka and Magendie through which the air gains access to the ventricular system.

"It was determined to study the ventricular system by doing a ventriculogram, which was carried out on July 30, a hole being bored in the bone in the occipital region on either side and air run through from one side to the other so that the ventricular system above the aqueduct of Sylvius was completely filled. The ventricles were very slightly dilated but in normal position. In particular,

the third ventricle was regularly outlined, especially its lower anterior portion near the optic chiasm.

"It is difficult to interpret the meaning of what we found. The only part of the ventricular system which we did not see was the fourth ventricle. If there was an obstruction to the ventricular system, it must have been between the foramen of Magendie and the aqueduct of Sylvius. But this obstruction could not be great since there had been no internal hydrocephalus and no signs of intracranial tension. The lack of filling of the sulci over the surface was such as one sees after any chronic encephalomyelitis or more usually after a hemorrhage in the subarachnoid space.

"At any rate there was no sign of any pathologic condition near the optic chiasm."

So, I have exhausted all means, having probably benefited the patient in some measure and having established certain negative facts at least. Final examination on Sept. 9, 1930, showed vision in the right eye to be 9/200 and that of the left eye 8/200.

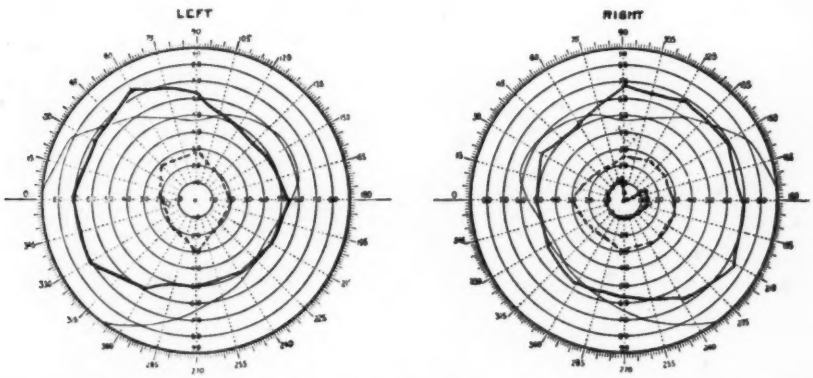

Fig. 7.—Visual fields on Sept. 9, 1930, seven months after operation. There was no scotoma. Vision was 9/200 in the right eye and 8/200 in the left. Vision for 1 mm., white, is indicated by the heavy solid line; that for 2 mm., blue, by the broken line, and that for 2 mm., red, by the dotted line.

CONCLUSIONS

This case with its clinicosurgical observations has been reported in detail for a twofold purpose. First because I felt that surgical exploration as illustrated offered the only possibility of improvement in a hitherto hopeless condition. The two brothers—one practically helpless with an untreated disease which had progressed to its full extent and the other with a left eye well on its way to complete disability and the right just beginning to be disabled, whose condition was not only arrested but improved so that he can hold a position—are a striking challenge to both the ophthalmologist and the neurosurgeon. Several men studying lesions of the brain and their frequent ophthalmologic symptoms and signs are irked and puzzled by the exact processes taking place in the chiasmal region. This report, while perhaps

throwing light on a new group of cases that may some day be accessible to surgery, also adds confusion to any relationship that an infectious (or maybe it is a developmental) process may have to a hereditary, sex and age limited disease.

The definite though negative signs disclosed by ventriculograms at least enables one to say that no destructive silent tumor mass is accountable for the atrophy of the optic nerve, there is no internal hydrocephalus with obstruction at or near the base of the brain, and postoperatively, no tight bands have formed over the nerve. The question is also raised concerning the mechanism of the temporary improvement many optic atrophies show on cranial operation of almost any type, for I feel that many reports of improvement disclose retrogression on later analysis. I should like to make a plea for the fearless reporting of these later setbacks so that those who are interested may study finished reports and not premature observations. My report may seem premature, but the observations up to date have excited sufficient comment to project them for the study of many instead of a few. My second reason for outlining this case is to excite comment and study from the angle of that ambiguous condition called arachnoidal pathology. I should like to gather together for correlation other people's experiences and views relative to chiasmal pathology, of this particular nature.

TUMORS OF THE QUADRIGEMINATE PLATE

A CLINICO-ANATOMIC STUDY OF SEVEN CASES *

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NEW YORK

The quadrigeminate plate is an anatomic landmark of particular interest to the ophthalmologist. Forming the roof of the aqueduct of Sylvius (fig. 1), it overlies the narrow channel through which the cerebrospinal fluid which collects in the lateral ventricles and the third ventricle is drained into the fourth ventricle and ultimately into the subarachnoid space, where it is either reabsorbed by the pial vessels or excreted by way of the arachnoid villi (fig. 2). It is obvious that an expanding lesion in the quadrigeminate plate is in a most favorable position, by compressing this aqueduct, to obstruct partially or completely the normal flow of the cerebrospinal fluid from the ventricular compartments, rostral (anterior) to the aqueduct of Sylvius and, in this way, cause the formation of internal hydrocephalus and precipitate clinical manifestations of increased intraventricular tension. Thus an expanding lesion in this region is apt to produce, among other signs and symptoms of increased intracranial tension, swelling of the disks which advances rapidly, reaching a high degree of papilledema early in the clinical course. No less significant is the fact that within the anterior quadrigeminate bodies there are the cellular aggregations (nuclei) which serve as important centers for the extrinsic, and probably the intrinsic, ocular mechanisms and that nearby is the nuclear material aggregated on the ventral aspect of the aqueduct of Sylvius (fig. 3) which includes the various nuclear subgroups of the oculomotor nerves with the nuclei of the trochlear nerves in close proximity. These anatomic relationships explain readily why the more striking clinical features of tumors in the region of the quadrigeminate plate are expressed in progressive disturbances of the extrinsic and intrinsic ocular mechanism and in rapidly advancing papilledema. These signs, however, while dominating the clinical picture, are not the sole clinical manifestations provoked by a lesion in this location, for the frequent

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* Read before the Section of Ophthalmology, New York Academy of Medicine.

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direct involvement of adjacent structures and the indirect influence on remote structures often produce other signs and symptoms which usually round out, but not infrequently confuse, the clinical picture.

In this contribution I am mainly concerned with the description of illustrative instances of expanding lesions in the region of the quadrigeminate plate. These lesions, as a rule, compress the aqueduct of Sylvius and thus cause the production of internal hydrocephalus. The internal hydrocephalus provokes a series of symptoms which are regarded as characteristic of increased intracranial tension and which are more specifically identified as the cardinal signs of tumor of the brain. With the advancing internal hydrocephalus certain structures forming the walls of the ventricular system often suffer as the result of

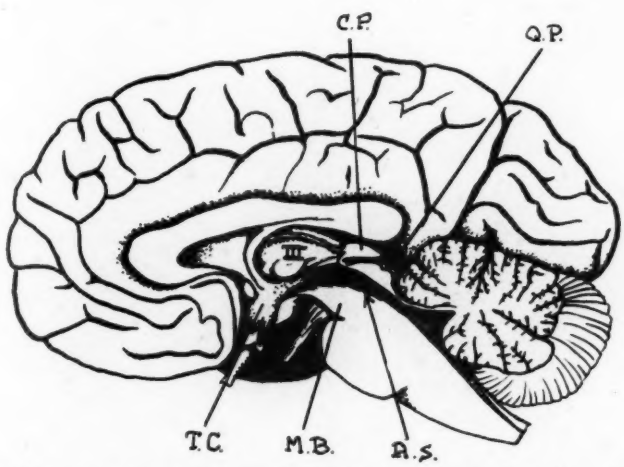

Fig. 1.—Median sagittal section of the brain, illustrating the relation of the quadrigeminate plate to the aqueduct of Sylvius. *III* indicates the third ventricle; *C.P.*, the pineal body; *T.C.*, the tuber cinereum; *M.B.*, the midbrain; *A.S.*, the aqueduct of Sylvius, and *Q.P.*, the quadrigeminate plate.

the progressive ventricular distention and provoke additional symptoms, which at times are somewhat misleading by simulating disturbances in part of the brain other than the quadrigeminate bodies. It is obvious how, as the result of advancing internal hydrocephalus due to an expanding lesion caudal (posterior) to the third ventricle, distention of the latter will lead to the thinning of the tuber cinereum (figs. 1 and 18) and distention of the lateral walls of the third ventricle. The anatomic alterations thus caused in the structures adjacent to the third ventricle are apt to give rise to signs and symptoms usually provoked by focal lesions in that region, such as polydipsia, polyuria, somnolence, sexual precocity, anomalies of growth and other manifestations of disturbed vegetative function. In this manner tumors, though strictly

limited to the quadrigeminate plate, may by indirect influence on remote anatomic structures provoke signs and symptoms characteristic of altered function of the tuber cinereum or the pituitary body, and thus lead to the error of either assigning to the pineal gland functions that belong to another organ or placing the lesion in the wrong location.

Anatomic alterations in the anterior quadrigeminate bodies caused by tumor, inflammation or any other lesion have been known for some time to be associated with impairment of the upward gaze or with skew deviation on upward gaze. As the lesion expands beyond the limits of the quadrigeminate plate, it makes inroads into the zone of

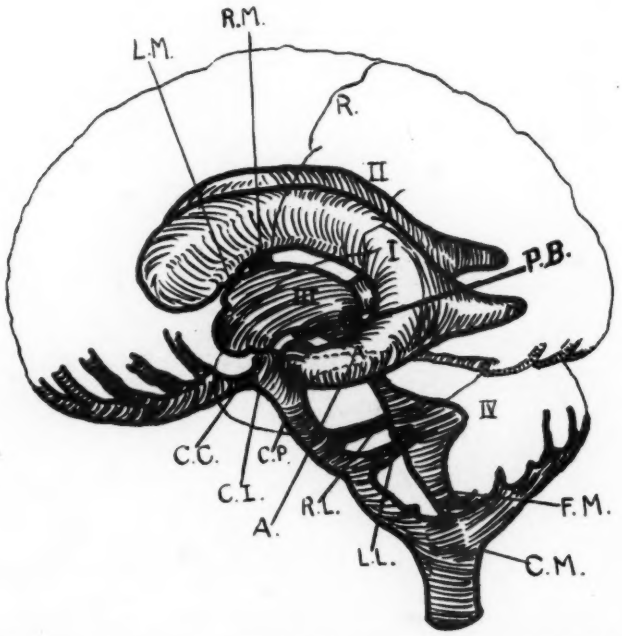

Fig. 2.—Diagram illustrating the circulation of cerebrospinal fluid and points of obstruction causing the two types of hydrocephalus (after Dandy). *I* and *II* indicate the left and right lateral ventricles; *L.M.* and *R.M.*, the left and right foramina of Monro, connecting the third with the lateral ventricles; *A*, the aqueduct of Sylvius, the channel connecting the third (*III*) with the fourth ventricle (*IV*). The foramen of Magendie (*F.M.*), an opening in the pia, permits the escape of intraventricular fluid into the subarachnoid space; *L.L.* and *R.L.* indicate the left and right foramina of Luschka, accessory channels connecting the fourth ventricle with the subarachnoid space; *C.P.*, *C.I.* and *C.C.* indicate the cisterna pontis, cisterna interpeduncularis and cisterna chiasmatica, respectively, and *C.M.*, the cisterna magna.

A block anywhere in the intraventricular channels and noted in tumors of the quadrigeminate plate causes obstructive hydrocephalus; when at *III* or *A* it causes the type of hydrocephalus associated with tumors of the quadrigeminate region. Obstruction at *C.P.*, *C.I.* or *C.C.* will produce communicating hydrocephalus.

the periaqueductal gray matter, either by pressure or by direct invasion. This results in anatomic distortions of the median and the lateral nuclei of the third cranial nerve, leading to functional disturbances in the intrinsic and extrinsic mechanisms of the eyes. These disturbances include typical Argyll Robertson pupils or various modified or irregular forms of the so-called Argyll Robertson pupil and at times complete internal ophthalmoplegia. In the disruption of the extrinsic mechanism

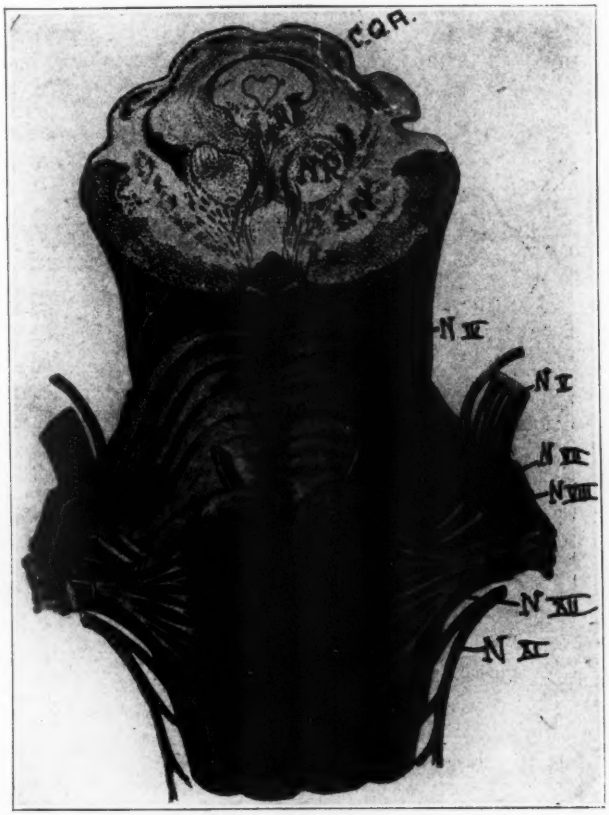

Fig. 3.—Semischematic reconstruction of the midbrain with cross-section at the level of the anterior quadrigeminate bodies, illustrating the location of the nuclear groups of the third cranial nerve and other structures of the midbrain. *C.Q.A.* indicates the anterior quadrigeminate bodies; *N III*, the nuclei of the oculomotor nerve; *N.R.*, the red nucleus (nucleus ruber); *S.N.*, the substantia nigra; *Py.*, the pyramidal tract; *N IV*, *N V*, etc., the exits of the cranial nerves.

there is also great irregularity in the relative involvement of the two eyes and in the degree of paralysis of the individual muscles. With the further expansion of the lesion other structures in the midbrain are encroached on (fig. 3). The pyramidal tracts, the red nuclei, the substantiae nigrae and the cerebellar peduncles become compressed, dis-

lodged or altered in one way or another, with the result that various forms of paralysis (tremors, muscle rigidities, abnormal gaits) are added to the clinical picture.

From the foregoing it may be assumed that tumors in the region of the quadrigeminate plate do not, as a rule, present difficult problems of diagnosis, for the appearance of signs and symptoms of increased intracranial tension, coupled with disturbances in the function of the intrinsic and extrinsic ocular muscles, is highly suggestive of a tumor in this location. Thus, in a patient who presents unquestionable signs and symptoms of increased intracranial tension associated with partial or complete external and internal ophthalmoplegia, impairment of upward gaze, skew deviation, cerebellar and pyramidal tract manifesta-

Fig. 4 (case 3).—Ventriculogram illustrating the marked distention of the ventricular system anterior to the aqueduct of Sylvius.

tions and signs of vegetative dysfunction, the diagnosis of tumor in the region of the quadrigeminate plate becomes a certainty. Technical aids are available, of course, to verify the diagnosis. Among them, ventricular estimation (puncture of the posterior horns of the lateral ventricles and quantitative estimation of the cerebrospinal fluid in both ventricles) and ventriculography (the introduction of air into the ventricle with subsequent roentgen examination) usually establish the existence of bilateral symmetrical internal hydrocephalus anterior to the aqueduct of Sylvius (fig. 4). In the majority of instances, however, a diagnosis may be arrived at by an appreciation of the fundamental anatomic and physiologic facts, so that mechanical diagnostic procedures will be found only of corroborative value, of little advantage and hence an unjustified hazard to the patient.

In mentioning the tumors in this location I have used the term neoplasm of the quadrigeminate plate, though in the literature they are usually described as tumors of the pineal gland or pinealomas. There is justification for all these terms. Tumors in this location may be called tumors of the quadrigeminate plate because they usually arise in that region, whence they may spread or be dislodged to other regions. The term tumor of the quadrigeminate plate not only helps to identify its exact anatomic location but also excludes the need for accepting the view that these tumors arise from the pineal gland itself. The term pineal tumor or the more recently suggested term pinealoma, on the other hand, finds its usefulness in the fact that tumors of the quadrigeminate plate take their origin from pineal rests, no matter where found, and in the course of their development recapitulate various phases of the developing pineal body, including the advanced histogenetic stage of the mature pineal gland.

Seven cases of tumor of this type are herein presented. They serve to illustrate features that typify the group as well as the somewhat disturbing departures found in the individual cases.

REPORT OF CASES

CASE 1.—*Symptoms of increased intracranial pressure for three years; bilateral papilledema; disturbances in the function of the intrinsic and extrinsic eye muscles; moderate pyramidal tract signs and, somewhat later, more pronounced signs; manifestations of cerebellar disturbance; a diagnosis of tumor of the quadrigeminate plate; ventriculography; exploratory suboccipital craniotomy; tumor not found; at necropsy, pinealoma found overlying and infiltrating the quadrigeminate plate.*

History.—H. F., a boy, aged 13, had been well until 10 years of age. He then began to complain of headaches, which recurred frequently during the subsequent three years. They had been accompanied by attacks of dizziness for the past year.

Examination.—This revealed an undeveloped boy, aged 13. His pupils were unequal, the right being larger than the left. They did not react to light but reacted in accommodation (Argyll Robertson pupils). There was bilateral papilledema (3 diopters in both eyes). The deep reflexes were hyperactive and equal; the superficial reflexes were normal. The Wassermann tests of the blood and cerebrospinal fluid were negative.

Course.—In spite of the negative serology, but in view of the Argyll Robertson pupils, juvenile taboparesis was suspected, and antisyphilitic treatment was given, though the swelling of the disks pointed strongly to an intracranial neoplasm. No change took place in the patient's condition during a short stay in the hospital, and he was allowed to return home. He was readmitted to the hospital two months later because of intensified headache and frequent vomiting.

Second Admission.—On readmission, the pupils again were fixed to light, but reacted normally in accommodation. There was bilateral weakness of the external rectus muscle, more marked on the right side, and slight weakness of the internal rectus and moderate weakness of the inferior rectus muscles on the left side. There were generalized hyperreflexia, bilateral ankle clonus, a suggestive Babinski

sign on the left side, slight ataxia in the right upper extremity, and a cerebellar gait and posture with a tendency to fall to the right.

At this time a diagnosis of neoplasm in the region of the quadrigeminal plate was made. Ventriculography revealed bilateral internal hydrocephalus (fig. 4). It was also noted that the posterior part of the third ventricle could not be visualized; this was thought to indicate extension of the tumor into this region. An exploratory craniotomy was performed, but it could not be completed because of active bleeding. The patient died three weeks after his second admission to the hospital.

Necropsy.—Gross Examination: The surface of the brain showed evidence of marked increase in the intracranial pressure; the fissures were narrowed and the convolutions flattened. The tuber cinereum was markedly distended, stretching and

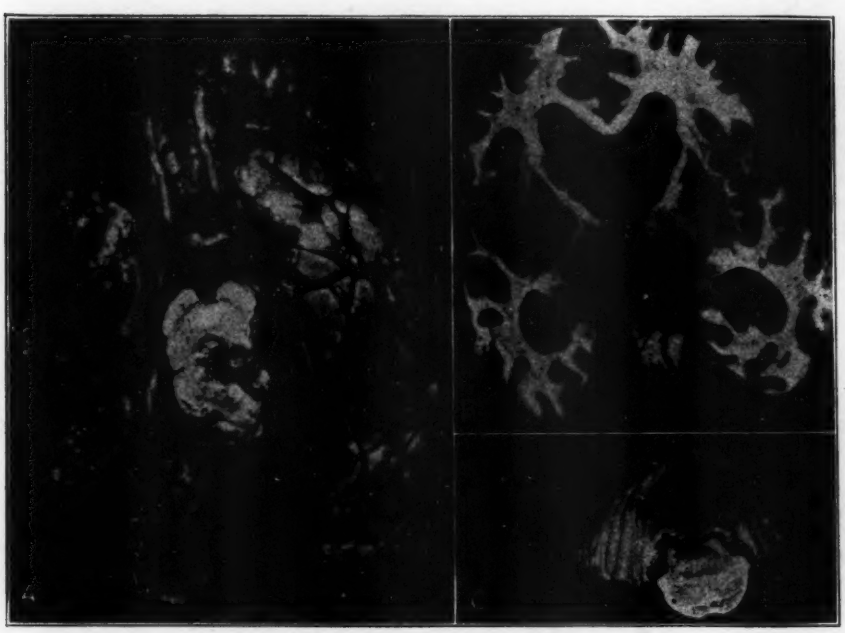

Fig. 5 (case 1).—Photograph of several sections of the brain, illustrating the character and location of the tumor. *A*, the base of the brain, showing the quadrigeminate plate replaced by a granular neoplastic mass; the aqueduct of Sylvius is seen as a semilunar slit in close proximity to the tumor, which appears below it in this illustration. *B*, horizontal section, illustrating the distended lateral ventricles. *C*, pons and cerebellum showing a softened hemorrhagic zone in the middle lobe of the cerebellum.

thinning out the overlying optic chiasm. On separating the cerebral hemispheres and exposing the quadrigeminal plate and the dorsal surface of the cerebellum, a large mass adherent to the falx cerebri was found protruding above the surface of the cerebellum (fig. 5). It measured about 2.5 cm. in diameter. It infiltrated the quadrigeminal plate and the anterior border of the cerebellum. This tumor mass, traced laterally, was found to infiltrate the cerebellum on the right side and the superior cerebellar peduncle on the same side. The pineal body was not found.

Microscopic Examination: Sections of the tumor displayed a striking histologic picture. Streams of small, deeply staining cells enveloped lighter areas containing nests of larger cells. The latter bore a strong resemblance to the parenchymal cells of the mature pineal body (fig. 6*A*). The two types of cells, the small and the large, were arranged in a mosaic which simulated strongly the histologic pictures presented by the pineal body in its early postnatal histogenetic phase, and assumed an architectural pattern imitating those seen in the pineal body of infants 3 weeks of age (fig. 6*B*). This feature as well as those shown by similar tumors justifies the assumption that in its histologic make-up the tumor recapitulated a chapter in the histogenesis of the pineal body; it points strongly to the probability that the tumor was derived from embryonal pineal rests in the region of the quadrigeminate plate. This histologic picture dominated the larger part of the tumor mass. There were also areas which showed various deviations from this typical cellular organization. In these fields, the large cells remained unchanged in outline and in number, whereas the small cells showed

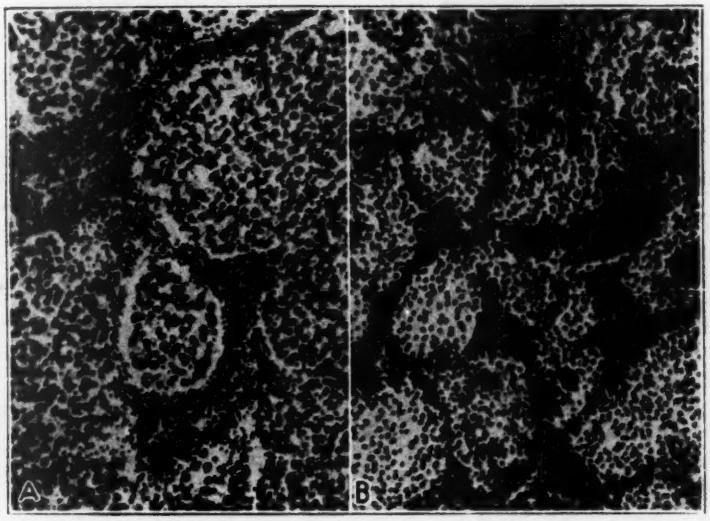

Fig. 6.—*A*, microscopic structure of the tumor in case 1. *B*, a microscopic structure of the pineal gland in an infant, aged 3 weeks.

a marked reduction in number. They were replaced by fibroblasts and collagenous fibers (fig. 7*A*) with the young fibroblasts taking the place of the gradually disappearing small cells.

Giant cells (fig. 7*B*) were also frequently found in various areas of the tumor, particularly near calcified material. They had the appearance of foreign body giant cells and occasionally assumed the character of large multinucleated macrophages with enclosures.

Comment.—This case furnishes a good example of tumor of the quadrigeminate plate, though it lacks some of the typical features. There was no skew deviation of the eyeballs, no pronounced involvement of the pyramidal tract (paralysis or paresis of the extremities, pathologic reflexes) and no midbrain manifestations (tremors, rigidities, propulsive

gait, etc.), exclusive of ocular involvement. It illustrates clearly the anatomic basis for the physiologic disturbances when the lesion is well circumscribed and limited to the quadrigeminate plate.

The diagnosis of juvenile paresis was never seriously considered, as may be gathered from the clinical record; the antisyphilitic therapy was given up after only a few injections of mercury.

Of interest also is the character of the finer structure of the tumor. It is discussed under microscopic observations and needs no further comment here. A more thorough description of the histologic features is given in a paper [1] that is to appear in the *Archives of Neurology and Psychiatry*.

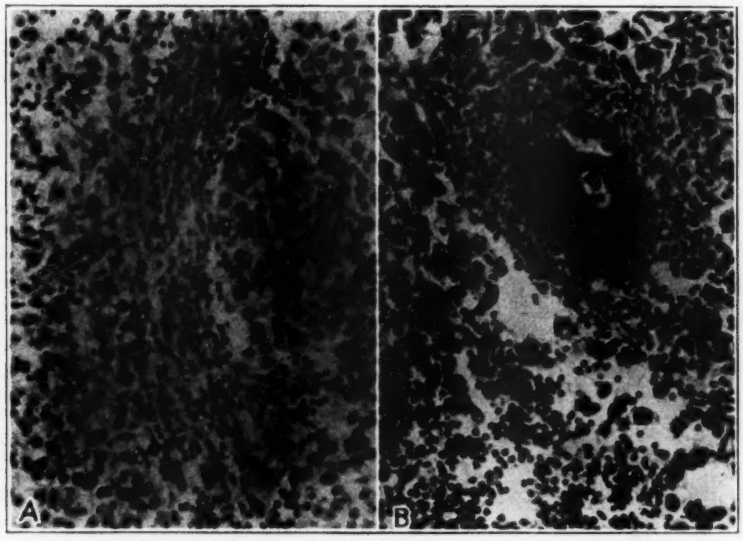

Fig. 7 (case 1).—*A*, a histologic variation; the small round cells are reduced in number and are replaced by fibroblasts. *B*, giant cells with enclosures.

CASE 2.—*Polydipsia and polyuria; later, manifestations of increased intracranial tension (headache, vomiting, dulling of intellect); diplopia; bilateral papilledema; disturbances in innervation of the extrinsic and intrinsic eye muscles; disruption in associated eye movements; pyramidal tract and cerebellar signs and features of vegetative disturbance (abnormal skeletal growth); tumor of the quadrigeminate plate suspected; ventriculography; incomplete exploratory craniotomy; tumor not found; spontaneous, temporary improvement; recurrence of symptoms; gradual decline; death; pinealoma of the quadrigeminate plate shown at necropsy.*

History.—S. A., a youth, aged 17, had drunk excessive amounts of water and voided large amounts of urine for one year preceding his admission to the hospital. About four months before admission, headaches developed abruptly; he began

1. Globus, J. H., and Silbert, S.: Pinealoma, Tumors of the Quadrigeminate Region, Arch. Neurol. & Psychiat., to be published.

to vomit frequently and became dull, disinterested and inefficient in his studies. Soon after, he complained of double vision and began to drag his right foot.

Examination.—The patient appeared unusually tall for his age. He walked on a wide base with a staggering gait, reeling to the right. The chin was turned to the right and the occiput to the left. There were slight ataxia in the right hand and slight athetoid movements in the left hand. The deep reflexes were somewhat more active on the left side. There was bilateral papilledema with hemorrhages and an elevation of both disks of about 4 diopters. The right pupil was larger than the left. The reaction to light was sluggish; the reaction in accommodation was not recorded. There were paresis of the right external rectus muscle and limitation of upward gaze, with skew deviation and ptosis of the right eyelid. The Wassermann test of the blood was negative.

Course.—A tumor in the region of the third ventricle and aqueduct of Sylvius was suspected. The lateral ventricles were punctured. At first, dye was injected into one ventricle and was recovered from the other, demonstrating that the foramina of Monro were open. This was followed by ventriculography which demonstrated pronounced internal hydrocephalus with marked dilation of the lateral and third ventricles. The posterior portion of the third ventricle was not visualized, and it was thought that the lesion about the aqueduct of Sylvius encroached on the posterior part of the third ventricle. An exploratory craniotomy was attempted, but, owing to considerable bleeding, was not completed. Infection of the wound set in, and the second stage of the operation had to be postponed. In the meantime, the patient began to improve. He became free from subjective complaints. Objectively he still revealed paralysis of upward gaze, unsteady gait and moderate ataxia in all four extremities, hyperactive deep reflexes and a Babinski sign on the left side, but strikingly enough the papilledema had disappeared. He continued to improve, so that he returned to school six weeks before his second admission to the hospital. There he soon developed what was described as pneumonia. From that time on he began to decline both mentally and physically.

Second Admission.—On readmission, the patient was emaciated, dull and mentally deteriorated. There was marked spasticity and contracture of the extremities with bilateral Babinski signs. The pupils were irregular and unequal, the right being larger than the left.

Course.—The complete disappearance of the papilledema was out of accord with the previous diagnosis of a tumor and suggested an inflammatory lesion as a possible underlying cause for the clinical picture. Foreign protein therapy was therefore initiated. After the first injection the temperature rose slowly to 106 F., and continued to climb as the patient's general condition declined; respiratory paralysis set in, causing death.

Necropsy.—Gross Examination: The brain was voluminous and under moderately increased pressure. When the occipital lobes were raised and the roof of the aqueduct of Sylvius and that of the fourth ventricle were exposed, a gelatinous semifluid mass was found covering those structures. The character of the mass could not be established on gross examination. Though it was assumed to be neoplastic, its true character had to await histologic study. The tuber cinereum was very thin. The ventricles were much distended. The distention involved all the divisions of the lateral ventricle and the cavity of the third ventricle. The quadrigeminate plate was replaced by a large mass of soft, friable and granular tissue (fig. 8). This mass measured about 2 cm. in width, 2 cm. in the anteroposterior diameter and about 3 cm. in depth posteriorly; a small calcareous body

was found to be a remnant of the pineal body. The midbrain was markedly distorted; its tectum and part of the tegmentum were almost completely destroyed. The nucleus ruber was small and the substantia nigra poorly pigmented. The aqueduct was large and filled with a soft, viscid mass.

Microscopic Examination: The histologic composition of this tumor was almost identical with that of the previous one. Here, again, small deeply staining

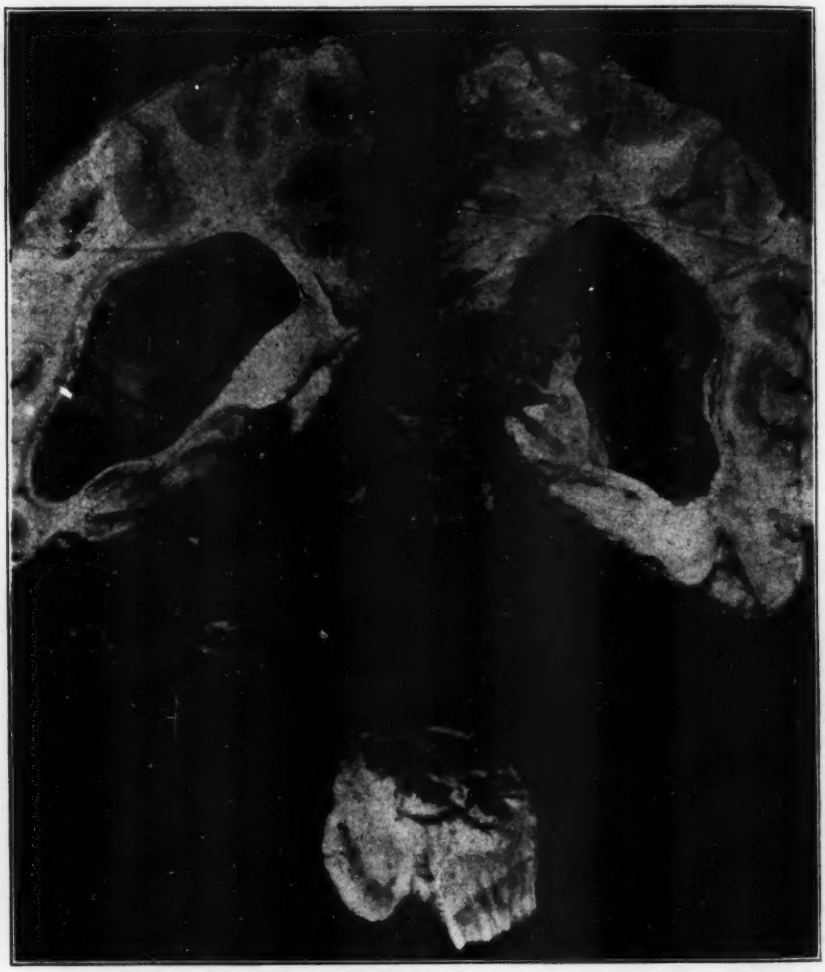

Fig. 8 (case 2).—The gross appearance of the tumor, its location and the artificial opening in the midbrain.

cells formed streams which engulfed nests of the clear parenchymatous cells (fig. 9), the former being fewer while the latter were larger. Transition stages of the small round cells into fibroblasts were also present and giant cells of the foreign body were also noted.

Comment.—The new features in this case were the manifestations of vegetative dysfunction, such as polydipsia and polyuria, and abnormal skeletal growth, as well as the skew deviation of the eyes. Interpreted

in the light of present knowledge of the anatomy and physiology of the interbrain, they make the clinical picture more complete. It is now more readily understood why physiologic disturbances resulting from anatomic distortion of the tuber cinereum may occur in expanding lesions restricted to the quadrigeminate plate. They will not mislead the well informed as to the logical location of the lesion because of a few less typical manifestations provoked by the indirect influence of the growth on remote structures. Of unusual interest also in this case is the disappearance of papilledema. For this unusual occurrence an explanation is readily found in the reopening of an artificial channel for the drainage of cerebrospinal fluid from the preaqueductal ventricular compartments. It serves to support the belief that papilledema is

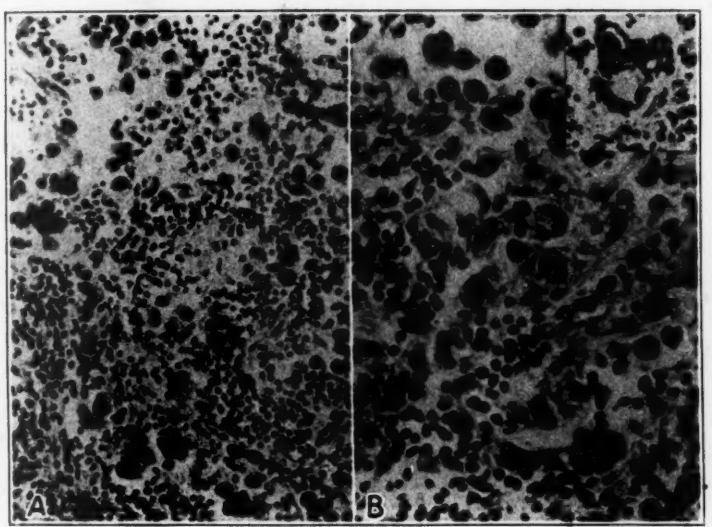

Fig. 9.—*A*, the microscopic structure of the tumor in case 2; note the similarity to case 1 (fig. 6). *B*, higher magnification of the same field, showing greater detail of the two cell types: the small deeply stained, and the large faintly stained, cells.

probably due to hydrocephalus, and that its intensity is in direct proportion to the extent and magnitude of the ventricular distention.

CASE 3.—*Symptoms of increased intracranial tension (headache, vomiting); later, diplopia and papilledema; impairment of extrinsic and intrinsic ocular mechanism; pyramidal tract signs; disturbances of the secondary sex characters; a diagnosis of tumor of the quadrigeminate plate; exploratory craniotomy in two stages; tumor not visualized; decline; death; pinealoma of the quadrigeminate plate revealed at necropsy.*

History.—P. S., a boy, aged 13 years, complained of frequent headaches for two years prior to admission to the hospital. They occurred in attacks and lasted for periods of from four to five hours. Two years later, he began to vomit and soon double vision developed.

Examination.—This revealed that the patient was well developed and well nourished. He displayed thick hair on his head but none in the axillae and little on the pubis. His external genitalia were larger than normal for his age. His pupils did not react to light, but reacted well in accommodation. There was a paresis of upward gaze, slight weakness of the right external rectus muscle, ptosis of the right eyelid and bilateral papilledema of 5 diopters in each eye. The visual fields were normal, and vision was reported as unimpaired. There was some weakness of the right arm and left leg and a questionable Babinski sign on the left side. The deep reflexes were normal. A roentgenogram of the skull revealed

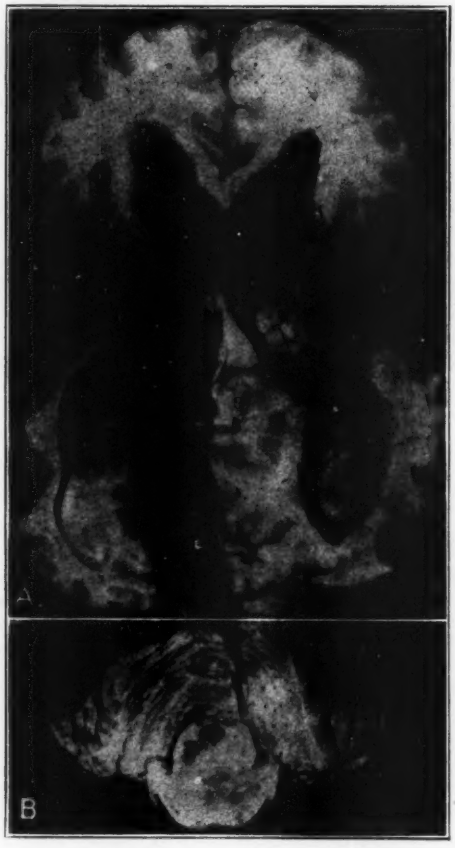

Fig. 10 (case 3).—*A*, the location of the tumor. *B*, softening in the periaqueductal gray matter.

calcification of the pineal body. The Wassermann test of the blood was negative. The cerebrospinal fluid was normal.

The diagnosis of tumor of the quadrigeminal plate was made. Ten days after admission an exploratory craniotomy was performed. Owing to considerable bleeding, only the first stage of the operation was carried out at this time. Ten days later the second stage was performed. No tumor was found. A ventricular puncture revealed marked dilatation of the ventricles (fig. 4). Following the operation, complete paralysis of upward gaze developed and the patient became increasingly lethargic. He declined gradually and died six months later.

Necropsy.—Gross Examination: The brain was under increased intracranial tension. The lateral ventricles and third ventricle were markedly dilated. The pineal body was large, calcified and attached to the firm tumor mass which occupied the region of the anterior notch of the cerebellum resting on the quadrigeminate plate (fig. 10). The tumor appeared to invade the pulvinar on the left side. It measured about 2.5 cm. in diameter.

Microscopic Examination: In this case, the histologic picture differed in some respects from that in the two preceding cases (cases 1 and 2). On careful scrutiny of the material, however, areas were discovered that had architectural features noted in the previous cases (fig. 11 *A*). In this tumor, however, the histologic structure indicated a more differentiated phase in the development of the pineal body. The small round cells were fewer in number (fig. 11 *B*). Instead of these cells there were robust bundles of collagenous fibers. Foreign body giant cells were numerous.

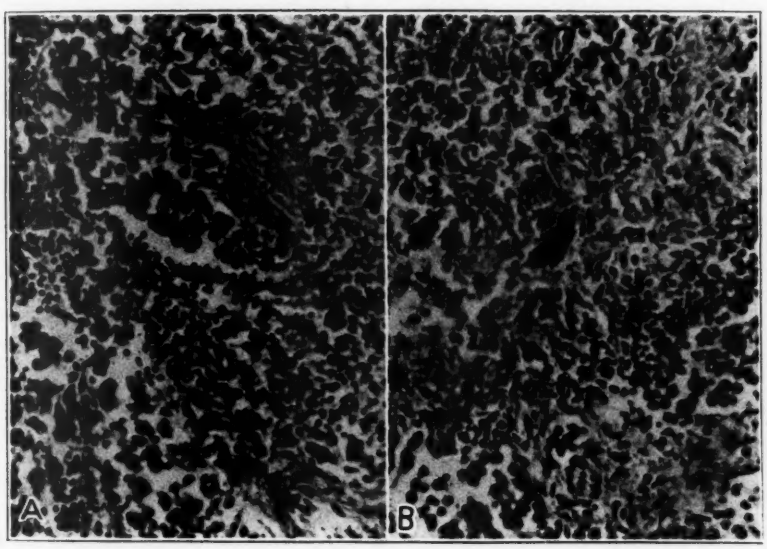

Fig. 11 (case 3).—*A*, microscopic structure of tumor. *B*, another field in the same tumor showing the presence of robust bundles of connective tissue and of giant cells.

Comment.—In this instance an added feature was the disturbance in the development of the secondary sex character. The anatomic basis for that is found in the alterations in the tuber cinereum secondary to the internal hydrocephalus.

CASE 4.—*Symptoms of increased intracranial tension (headache, vomiting, fainting spells); later, tremors, dysarthria, incontinence and diplopia; objective symptoms: papilledema, disturbances in innervation of the intrinsic and extrinsic ocular muscles, and mild pyramidal and cerebellar signs; diagnosis, neoplasm of the quadrigeminate plate; suboccipital craniotomy; no tumor found; decline; death; pinealoma revealed at necropsy.*

History.—J. B., a man, aged 30, nine weeks prior to his admission to the hospital began to suffer with headaches, which at first were mild and intermittent, but which later became severe and continuous. He vomited frequently and complained of generalized weakness. He became subject to fainting spells; somewhat later, tremor on voluntary movement and progressive difficulty in speech developed. Two weeks before admission to the hospital he began to show urinary incontinence. For one week he had experienced double vision.

Examination.—The patient appeared well developed and well nourished. He was irritable and confused. The head was in the cerebellar posture with the chin turned to the left and the occiput to the right. His gait was cerebellar in type and he showed a tendency to fall backward and to the left. There was bilateral papilledema with hemorrhages; the elevation was 3 diopters in both eyes. The pupils were unequal, the left being greater than the right. Both reacted sluggishly to light. The reaction in accommodation was not recorded. There was complete

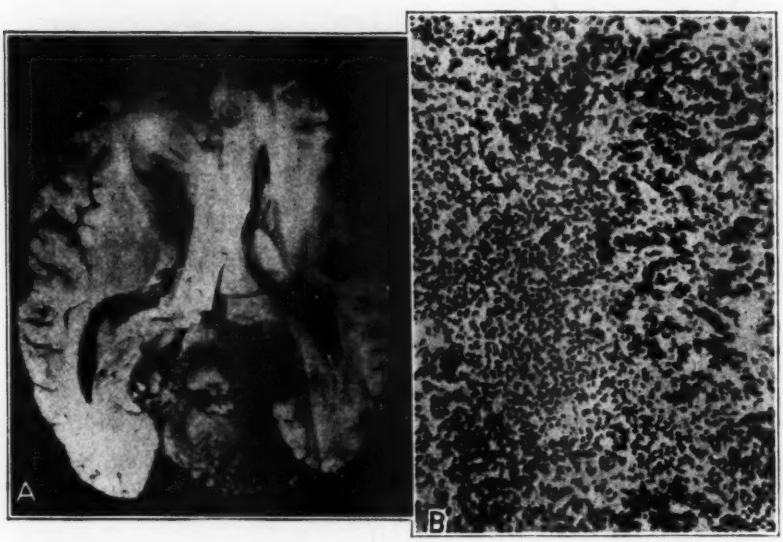

Fig. 12 (case 4).—*A*, location of tumor. *B*, histologic appearance of tumor.

paralysis of the left external rectus muscle and slight weakness of the right external rectus muscle. There was ptosis of the right upper lid. The deep reflexes were somewhat more active on the right side. There was ataxia of the left upper extremity.

Course.—A diagnosis of neoplasm, probably in the posterior fossa, was made. An exploratory suboccipital craniotomy was performed in two stages. No neoplasm was found. Following the operation, deviation of the jaw to the left and definite changes in the distribution of the left fifth nerve were noted. The upward and downward gaze remained normal. The papilledema did not recede. The patient became progressively more drowsy, and he died two months after admission to the hospital.

Necropsy.—Gross Examination: The brain was under markedly increased intracranial tension. On the dorsal surface of the cerebellum in the region of the vermis there was a large mass (fig. 12 *A*). It extended laterally to both cerebellar hemispheres and forward as far as the quadrigeminal plate. It measured about

7 cm. in its long axis, 6 cm. in its transverse diameter, and about 8 cm. in its dorsoventral axis. The mass was encapsulated and easily separated from adjacent cerebellar tissue. It was irregular in outline, with several small nodules mounted on its dorsal surface. The lateral ventricles presented a picture of bilateral symmetrical internal hydrocephalus. The pineal body, normal in outline and size, was found in its normal location.

Microscopic Examination: In this case, as in case 3, departures from the typical structure of pinealoma were numerous, but diligent search led to the discovery of areas characterized by the mosaic, produced by streams of small round cells splitting larger masses of parenchyma cells (fig. 12 *B*).

Comment.—Some of the clinical features in this case, such as the dysarthria, and the marked cerebellar signs, misled the observers, who placed the lesion in the posterior fossa and not in the quadrigeminate plate. This determined the surgical approach by way of a suboccipital craniotomy. It illustrates the fallacy of allowing a few signs to carry one away from the well defined syndrome of tumor of the quadrigeminate plate, thus failing to localize the lesion correctly.

CASE 5.—*Impaired visual acuity with episodes of diplopia; then headache of increasing severity; disturbances of the extrinsic and intrinsic ocular muscles and mild pyramidal tract signs; suspected tumor of the midbrain (in the region of the quadrigeminate plate?); ventricular estimation; convulsive seizures; advancing signs of increased intracranial tension; suboccipital craniotomy; no tumor found; death; pinealoma revealed at necropsy.*

Examination.—This revealed a normally developed man, aged 35. The pupils were dilated and responded sluggishly to light but normally in accommodation. There was distinct impairment of upward gaze. The fundi were hyperemic, but otherwise normal. The visual fields were normal. There was slight bilateral weakness of the internal rectus muscle and slight weakness of the right side of the face. The deep reflexes were more active on the right side.

Course.—A diagnosis of tumor in the region of the midbrain was made. On ventricular estimation both ventricles were found markedly dilated. Phenolphthalein injected into one lateral ventricle promptly appeared on aspiration of the other. This led to the conclusion that there was a bilateral hydrocephalus and that the foramina of Monro were patent. During the third week of his stay in the hospital the patient had several slight convulsive seizures characterized by stiffening of the left, and at times the right, side of the body, without loss of consciousness. At the end of three weeks he returned home. During the next three weeks his symptoms were intensified. The headaches became more frequent and vision poor.

Second Admission.—On readmission to the hospital, the right pupil was much smaller than the left; both reacted sluggishly to light and normally in accommodation. There was limitation of upward gaze, weakness of the right external rectus muscle, slight weakness on the right side of the face, equally hyperactive deep reflexes, active superficial reflexes and a Babinski sign on the right side. The fundi showed moderate blurring but no measurable elevation.

One week after his admission to the hospital a suboccipital craniotomy was performed. Owing to excessive bleeding, only the first stage was completed. Two weeks later, the second stage was carried out. The posterior fossa was care-

fully explored, but no tumor was found. Soon after the operation, the patient's wound became infected and signs of meningitis appeared. He died a month after the second admission.

Necropsy.—Gross Examination: A tumor was found on the dorsolateral aspect of the brain over the quadrigeminate plate (fig. 13). It was well encapsulated and easily separated from the adjacent midbrain substance. It measured about 5 cm. in the greatest diameter. It was irregularly round and nodular.

Microscopic Examination: A thorough search through the various portions of the tumor disclosed, among many atypical and even foreign architectural designs (fig. 14), the histologic fields characteristic of pinealoma (fig. 15).

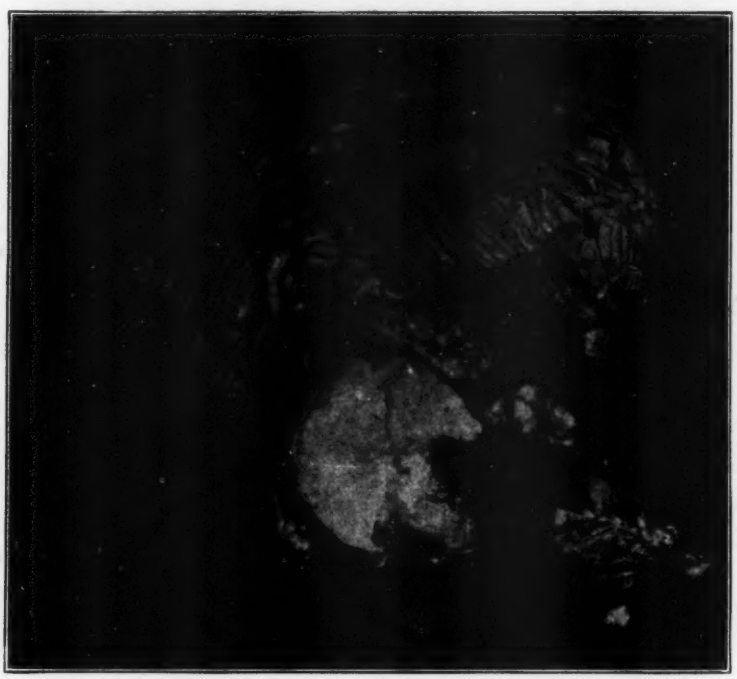

Fig. 13 (case 5).—Gross appearance and location of tumor.

Comment.—In this case the tumor was not strictly a quadrigeminate neoplasm, if one considers its location. It was found on the side of the midbrain. Since it gave rise to the syndrome of a lesion of the quadrigeminate plate, however, and since by structure it was a pinealoma, it may be safely considered as a member of the group.

Histologically, in some areas it presented the structures of a histogenetically more advanced pineal gland, alongside of areas that revealed the typical pattern of pinealoma.

CASE 6.—*Several departures in the clinical picture of this condition, some of them explained by the unusual extension of the lesion; others only apparent, as their true character was revealed by necropsy.*

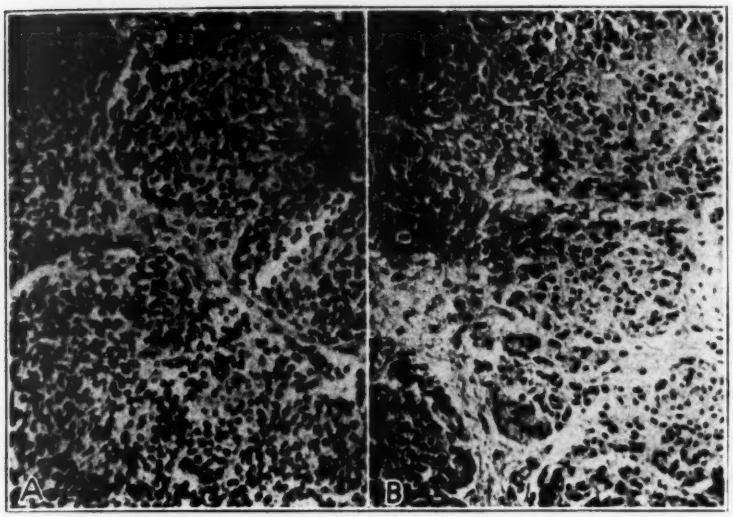

Fig. 14.—*A*, an atypical microscopic field of the tumor in case 5; note its lobular character. *B*, histologic appearance of pineal gland in child aged 5½ years.

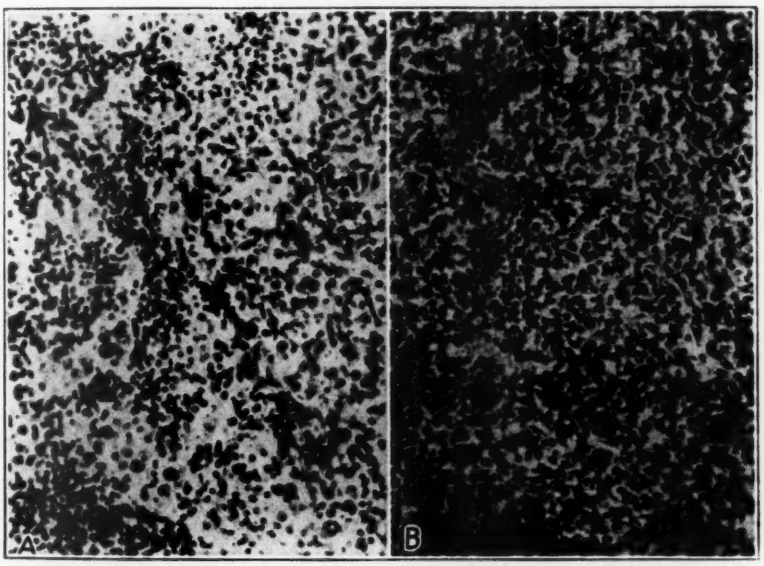

Fig. 15.—*A*, a more typical field of the tumor in case 5. The two cell types are easily discerned, but the characteristic mosaic is not well retained. *B*, typical histologic structure of pineal gland in an infant, aged 4 months.

History.—A. G., a girl, aged 11 years, was well until the age of 9, when she fell and struck her head. On two subsequent occasions she stumbled, fell and again struck her head. Four months before admission to the hospital she complained of abdominal pain, nausea and occasional vomiting. Somewhat later she began to complain of headache. For five weeks before admission she complained of diplopia and difficulty in vision; she said that she could see better on lateral gaze than on looking straight ahead.

Examination.—The patient was a well nourished girl. She was drowsy, but when aroused, was irritable and resisted examination. There was bilateral papilledema with an elevation of about 2 diopters. The pupils were equal and reacted sluggishly to light; the reaction in accommodation was not recorded. There was ptosis of the right upper eyelid and weakness of the conjugate deviation to the right. The cerebrospinal fluid and the blood Wassermann tests were negative.

Course.—A diagnosis of neoplasm in the posterior fossa was made though its location about the aqueduct of Sylvius was suspected. A two-stage suboccipital craniotomy was performed, but no tumor was discovered in the posterior fossa. The patient's vision declined rapidly and she became totally blind when the pupils became fixed to light. She also became deaf. Six weeks after admission to the hospital, the right upper and lower extremities became completely paralyzed. The left upper and lower extremities were freely movable, but what were considered as cerebellar alterations were noted in the movements of the left hand. The patient deteriorated gradually and died ten weeks after admission.

Necropsy.—Gross Examination: The brain showed evidence of increased intracranial tension. On lifting up the occipital lobes, a soft tumor was exposed (fig. 16). It extended from the superior vermis up to the quadrigeminal plate and further forward, as revealed by cut sections of the brain. A large colloid cyst was found occupying the right lateral ventricle (fig. 16). It completely filled this ventricle as far forward as the foramen of Monro and posteriorly as far as the junction of the descending and posterior horns. It then extended backward over the roof of the aqueduct of Sylvius, where it embedded itself in a depression over the lateral lobe and vermis of the cerebellum, almost completely destroying the tectum of the midbrain and some of the tegmentum on the left side. The ventricular cavities were markedly distended. The third ventricle was widely open, but deformed and displaced to the left. The cyst had a well defined capsule, which measured about 2 mm. in thickness. It was free in its anterolateral aspect but was adherent to adjacent tissues in its ventromedian aspect. It was filled with a grayish-green jelly-like substance, and on its ventral surface it presented a small spongy mass which was cystic in some parts. These areas bore a striking resemblance to the structure of the pineal body. The pineal body could not be found.

Microscopic Examination: The finer structure of this tumor revealed a strong similarity to that of an adult pineal gland (fig. 17). In spite of her youth the patient had a pineal tumor of a highly differentiated make-up, which may be regarded as an adult pinealoma.

Comment.—The somewhat blurred clinical picture presented by this case is explained by the fact that the patient was seen late in the clinical course and because of the unusual expansion of the lesion, which broke into the lateral ventricle.

Of added interest in this case is the histologic character of the tumor and its exemplification of the various ways in which a tumor of this type may expand.

CASE 7.—*Pinealoma in a young child; invasion of the quadrigeminate plate and adjacent structures; pineal body well preserved; histologically, several phases in the evolution of the pineal body shown in structure of tumor.*

History.—M. S., a boy, aged 20 months, born at term, apparently developed normally until five weeks before admission to the hospital, when he fell backward,

Fig. 16 (case 6).—The gross appearance and location of tumor and the destruction of the tectum mesencephali by the cyst.

striking his head. Three hours later, he bled from his mouth for ten minutes. During the next two weeks he vomited frequently, and passed through a convulsive episode, lasting about ten minutes, in which his whole body became rigid. During the next two weeks he began to vomit repeatedly and became apathetic and listless. In the forenoon of the day of admission, he had another generalized convulsion, which lasted about ten minutes; he then passed into a state of decerebrate rigidity with loss of consciousness.

Examination.—The child was in coma; the body was rigid and all extremities were in extension (decerebrate rigidity). The knee jerks and the abdominal

History.—A. G., a girl, aged 11 years, was well until the age of 9, when she fell and struck her head. On two subsequent occasions she stumbled, fell and again struck her head. Four months before admission to the hospital she complained of abdominal pain, nausea and occasional vomiting. Somewhat later she began to complain of headache. For five weeks before admission she complained of diplopia and difficulty in vision; she said that she could see better on lateral gaze than on looking straight ahead.

Examination.—The patient was a well nourished girl. She was drowsy, but when aroused, was irritable and resisted examination. There was bilateral papilledema with an elevation of about 2 diopters. The pupils were equal and reacted sluggishly to light; the reaction in accommodation was not recorded. There was ptosis of the right upper eyelid and weakness of the conjugate deviation to the right. The cerebrospinal fluid and the blood Wassermann tests were negative.

Course.—A diagnosis of neoplasm in the posterior fossa was made though its location about the aqueduct of Sylvius was suspected. A two-stage suboccipital craniotomy was performed, but no tumor was discovered in the posterior fossa. The patient's vision declined rapidly and she became totally blind when the pupils became fixed to light. She also became deaf. Six weeks after admission to the hospital, the right upper and lower extremities became completely paralyzed. The left upper and lower extremities were freely movable, but what were considered as cerebellar alterations were noted in the movements of the left hand. The patient deteriorated gradually and died ten weeks after admission.

Necropsy.—Gross Examination: The brain showed evidence of increased intracranial tension. On lifting up the occipital lobes, a soft tumor was exposed (fig. 16). It extended from the superior vermis up to the quadrigeminal plate and further forward, as revealed by cut sections of the brain. A large colloid cyst was found occupying the right lateral ventricle (fig. 16). It completely filled this ventricle as far forward as the foramen of Monro and posteriorly as far as the junction of the descending and posterior horns. It then extended backward over the roof of the aqueduct of Sylvius, where it embedded itself in a depression over the lateral lobe and vermis of the cerebellum, almost completely destroying the tectum of the midbrain and some of the tegmentum on the left side. The ventricular cavities were markedly distended. The third ventricle was widely open, but deformed and displaced to the left. The cyst had a well defined capsule, which measured about 2 mm. in thickness. It was free in its anterolateral aspect but was adherent to adjacent tissues in its ventromedian aspect. It was filled with a grayish-green jelly-like substance, and on its ventral surface it presented a small spongy mass which was cystic in some parts. These areas bore a striking resemblance to the structure of the pineal body. The pineal body could not be found.

Microscopic Examination: The finer structure of this tumor revealed a strong similarity to that of an adult pineal gland (fig. 17). In spite of her youth the patient had a pineal tumor of a highly differentiated make-up, which may be regarded as an adult pinealoma.

Comment.—The somewhat blurred clinical picture presented by this case is explained by the fact that the patient was seen late in the clinical course and because of the unusual expansion of the lesion, which broke into the lateral ventricle.

Of added interest in this case is the histologic character of the tumor and its exemplification of the various ways in which a tumor of this type may expand.

CASE 7.—*Pinealoma in a young child; invasion of the quadrigeminate plate and adjacent structures; pineal body well preserved; histologically, several phases in the evolution of the pineal body shown in structure of tumor.*

History.—M. S., a boy, aged 20 months, born at term, apparently developed normally until five weeks before admission to the hospital, when he fell backward,

Fig. 16 (case 6).—The gross appearance and location of tumor and the destruction of the tectum mesencephali by the cyst.

striking his head. Three hours later, he bled from his mouth for ten minutes. During the next two weeks he vomited frequently, and passed through a convulsive episode, lasting about ten minutes, in which his whole body became rigid. During the next two weeks he began to vomit repeatedly and became apathetic and listless. In the forenoon of the day of admission, he had another generalized convulsion, which lasted about ten minutes; he then passed into a state of decerebrate rigidity with loss of consciousness.

Examination.—The child was in coma; the body was rigid and all extremities were in extension (decerebrate rigidity). The knee jerks and the abdominal

reflexes were not elicited. The fundi showed moderate papilledema. A lumbar puncture yielded clear fluid under markedly increased pressure, containing 60 lymphocytes. The patient died shortly after admission.

Necropsy.—Gross Examination: The brain was under increased intracranial pressure. There was marked internal hydrocephalus. A soft necrotizing tumor mass was found in the region of the quadrigeminate plate. It invaded posteriorly the vermis of the cerebellum, and laterally the right occipital lobe (fig. 18). The ventricular distention involved the third ventricle. The pineal body was found in its normal location.

Microscopic Examination: Attention need only be called to the striking similarity of the structure to that of the pineal gland itself in this case (fig. 19). It offers no difficulty in the recognition of the architecture of the so-called pinealoma.

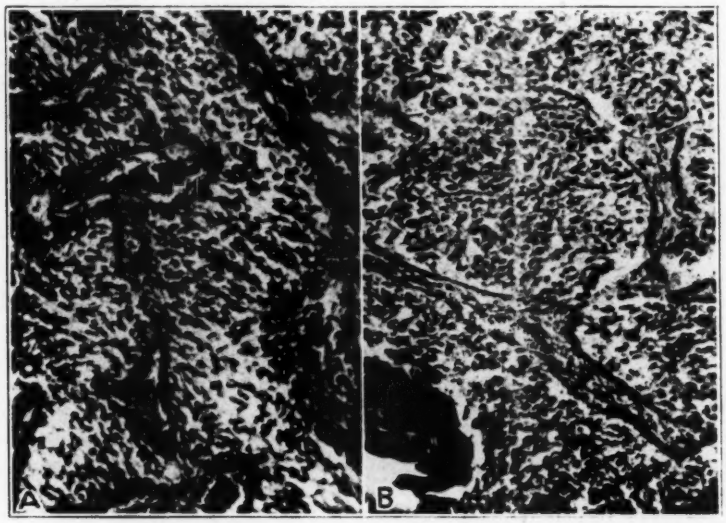

Fig. 17.—*A*, microscopic structure of tumor in case 6. *B*, histologic appearance of an adult pineal gland.

Comment.—It is obvious that this case is not instructive from the clinical point of view. It illustrates, however, that tumors of this type may occur in early infancy, and, since they may show advanced differentiation at an early stage, as in this case, their existence in the prenatal life of the patient is not improbable. It also shows that the age of the patient does not determine the degree of differentiation of the tumor. This becomes more apparent when this case and case 6 are compared with cases 1 and 2.

GENERAL COMMENT

A survey of the clinical records of six of the seven cases herein recorded discloses an array of signs and symptoms which typify tumors in the region of the quadrigeminate plate. The more prominent clinical features of tumors in this location, in the order of their importance,

Fig. 18 (case 7).—Gross appearance and location of tumor, distention of the third ventricle and thinning out of the tuber cinereum.

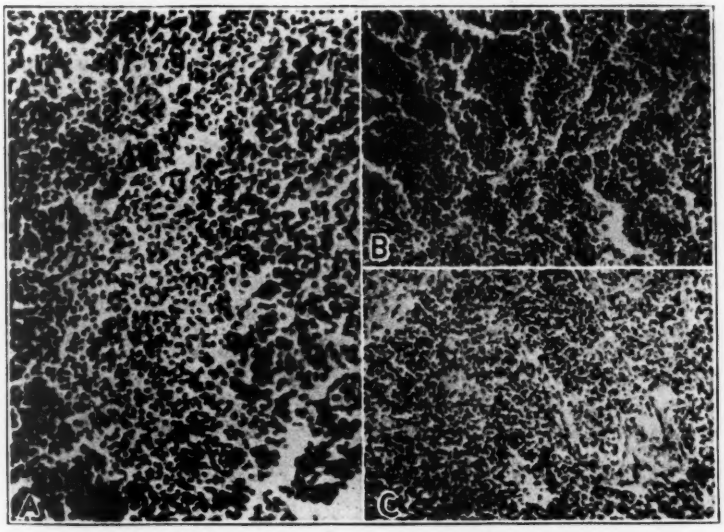

Fig. 19 (case 7).—*A*, a microscopic field in tumor, presenting the structure characteristic of penealoma; *B*, histologic appearance of pineal gland; *C*, histologic appearance of the average microscopic field of tumor.

are: (1) manifestations of increased intracranial tenson (headache, vomiting, papilledema); (2) ocular disturbances (ophthalmoplegias of various types and of various degrees of intensity, diplopia, paralysis of upward gaze, skew deviation and other forms of dissociation of ocular movements); (3) midbrain signs (tremors, rigidity, retropulsion); (4) cerebellar signs (posture of the head, unsteady gait and station, intention tremors, awkward execution of skilled movements); (5) pyramidal tract signs (loss of power in extremities, exaggeration of deep reflexes and the presence of pathologic reflexes [Babinski sign, etc.]).

Among the less constant and indirect signs and symptoms are: (1) mental disturbances (dulling or depreciation of intellect), and (2) vegetative dysfunctions (somnolence, polydipsia, polyuria, changes in skeletal growth, disturbances in development of secondary sex characters).

All of the enumerated manifestations find full explanation in recognizable anatomic alterations. The so-called cardinal signs of increased intracranial tension have already been referred to in the introductory lines of this paper, and need not be discussed again, except perhaps to emphasize that tumors of the quadrigeminate plate occupy a favorable location for the production of rapidly advancing internal hydrocephalus, which is instrumental in the causation of increased tension within the cranial cavity.

The ocular disturbances have also been touched on, but their greater significance merits a more detailed discussion under several headings:

Argyll Robertson Pupil.—In its typical or atypical forms, the Argyll Robertson pupil occurs frequently in tumors of the quadrigeminate plate. This phenomenon may no longer be considered as pathognomonic of syphilitic infection of the central nervous system, as it is often noted in acute epidemic encephalitis and in tumors in the periaqueductal region. The anatomic factors instrumental in the production of this dissociated pupillary action are as yet not clearly defined, but they are readily understood when it is recalled that the pathway for the light reflex is separable from that of the accommodation reflex.

In the former the afferent arc is formed by fibers running in the optic nerve, which are relayed or which pass through the lateral geniculate body, the anterior brachium to the anterior quadrigeminate body and from there, by a new set of short fibers, to the visceral nucleus of the oculomotor nerve. A lesion near or in the quadrigeminate bodies interrupting the afferent arc will disturb or completely cut the light reflex arc. On the other hand, the afferent arc for the accommodation reflex which takes an entirely independent course, traveling by way of the afferent fibers arising in the eye muscles, may remain intact and thus give rise to a typical Argyll Robertson pupil. In progressively

expanding lesions these fibers may also be compromised and partial involvement of the accommodation reflex may occur; in this way various departures from the typical Argyll Robertson pupil may become manifest. The experimental production of Argyll Robertson pupils [2] by bilateral section of superior brachium, at the point of entrance of the optic fibers into the anterior quadrigeminate bodies, adds support to the assumption that an interruption in the afferent pathway in this location is responsible for the Argyll Robertson pupil. It is to be recalled, however, that other workers have suggested that lesions in other structures may be responsible for the Argyll Robertson pupil. Thus, Marina [3] and Lafon [4] suggested the ciliary ganglion, and Bach [5] the fourth ventricle. The fact, that five of seven cases herein reported showed this form of iridoplegia points strongly to the anterior quadrigeminate bodies or to some region in close proximity as the seat of the lesion responsible for the Argyll Robertson pupil.[6]

Paralysis of Upward Gaze.—Here again no definite conclusion has as yet been reached as to the location of the lesion responsible for the disruption of this form of balanced eye movement. Kornilow,[7] in a discussion of this problem, pointed out that a supranuclear coordinating center is requisite for the associated movement, that this center is probably situated somewhere in the periaqueductal region, but not in the quadrigeminate bodies, and that lesions in the quadrigeminate region are likely to produce such paralysis by an indirect effect on this center. He cited, however, eight cases of cerebral tumor with this form of paralysis, in which the quadrigeminate bodies were not the seat of the tumor. In four of my cases this phenomenon was present. This would indicate that involvement of structures in close proximity to the quadrigeminate bodies is responsible for the phenomenon. No other deductions can as yet be drawn.

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6. A good review of the entire subject of the Argyll Robertson pupil will be found in the article by S. A. Kinnier Wilson (Some Problems in Neurology: I. The Argyll Robertson Pupil, J. Neurol. & Psychopath. **2**:1, 1921).

7. Kornilow, A. V.: Zur Frage der Associationslähmungen der Augen, Deutsche Ztschr. f. Nervenh. **23**:417, 1903.

Skew Deviation (Magendie Squint).—By this form of vertical divergence of the eyeballs is understood a forced position of the eyes, in which one eye is directed outward and downward and the other inward and upward. A good illustration of this dissociation of extrinsic ocular muscle mechanism appeared in a paper by Gordon-Holmes and was reproduced in the textbook of Jelliffe and White [8] (fig. 20). Magendie [9] was the first to describe this form of dissociated position of the eyes. He was able to produce it experimentally by cutting the middle cerebellar peduncle in the rabbit. He assumed that a lesion in this location is responsible for this phenomenon in man. The fact that it is often associated with other cerebellar manifestation would seem to support it.

Fig. 20.—Position of eyes in skew deviation (Gordon-Holmes' case).

In my material, however, skew deviation was found in only one case. It was associated with moderate cerebellar signs. Little new evidence has been added to the experimental evidence of Magendie, except that the condition may be produced by unilateral extirpation (De Kleijn [10]) of the vestibular apparatus. Thus Purves-Stewart [11] expressed the

8. Jelliffe, Smith Ely; and White, William: Diseases of the Nervous System, ed. 5, Philadelphia, Lea & Febiger, 1929, p. 385.

9. Magendie, F.: Sur les fonctions de quelques parties du système nerveux, J. de physiol. expér. et path. **4**:399, 1824.

10. De Kleijn, A.: Experimental Physiology of the Labyrinth, Proc. Roy. Soc. Med. (Sect. Otol.) **17**:20, 1923-1924.

11. Purves-Stewart, James: Diagnosis of Nervous Diseases, ed. 6, London, Edward Arnold & Company, 1924, p. 613.

belief that skew deviation is due, not to cerebellar lesion, but to disease of the adjacent nucleus of Deiter (lateral vestibular nucleus).

External Ophthalmoplegia.—Little need be said here with regard to palsies of the extrinsic muscles of the eyes since the site of the lesion, causing destruction of one or more somatic nuclei of the third nerves in varying degrees, will result in paralysis of the extrinsic muscles of the eyes, varying correspondingly in degree and extent.

Conjugate Deviation of the Eyes.—This phenomenon occurred in one case only. It is not, of course, pathognomonic of a lesion in the quadrigeminate plate, and was provoked in this instance (case 6) by the extensive spread of the lesion into the ventricular cavity.

Diplopia.—Double vision was a frequent manifestation. It was found in six cases. Its occurrence is easily understood when the disruption of the extrinsic mechanism is taken into account.

Nystagmus.—The absence of nystagmus in all of the cases described must be considered of great diagnostic significance, since it helps to exclude the contents of the posterior fossa as the seat of the lesion.

Vegetative Dysfunctions.—Disturbance in the vegetative functions was noted in only one case (case 2), which showed polydipsia, polyuria, precocious skeletal growth and somnolence. In explaining these manifestations attention was drawn to the effect of the hydrocephalus on the tuber cinereum, the part of the hypothalamus which, as already stated, is regarded as the seat of several nuclei, serving as controlling centers for vegetative functions (water, salts, carbohydrate and fat metabolism, skeletal growth, development of secondary sex characters, etc.). The fact that such disturbances were found in only one of my cases speaks definitely against the probability that tumors in the quadrigeminate plate are directly responsible for the phenomena.

Sexual Precocity.—For some time it was claimed that the pineal body has a controlling influence on the development of the sex characters, and that tumors of the pineal gland are capable of producing features of sexual precocity, macrogenitosomia praecox. The existence of questionable features of this nature in only one of my cases (case 3) does not seem to favor this conception.

Pyramidal Tract Signs.—By these signs are understood various degrees of paralysis, exaggerated deep reflexes and pathologic reflexes (Babinski sign, clonus, etc.). They were present in varying degrees in all my cases. Figure 3 shows how tumors in the region of the midbrain, indirectly compressing the pyramidal tracts, are apt to produce manifestation of involvement of these tracts.

Extrapyramidal Features.—The close proximity of the compressing lesion to the nucleus ruber and substantia nigra (fig. 3) may provoke signs characteristic of disease of the midbrain. Tremors of isolated

extremities, rigidity of the muscles of facial expression, and rigidity of muscles of the trunk and extremities may produce a picture simulating the parkinsonian syndrome. When they are mild and are associated with cerebellar signs, however, their evaluation is difficult. It is significant that manifestations of this character were present in only one case (case 2).

Cerebellar Dysfunction.—An injury to the anterior cerebellar peduncles is known to produce almost all of the cerebellar manifestations on the side of the lesion. They include intention tremors, impairment of skilled movement (adiadokokinesis), staggering gait and falling to one side. Tumors of the quadrigeminate plate, because of the proximity of the latter to the superior cerebellar peduncles, are likely to involve the brachium conjunctivum. This explains the frequent occurrence of cerebellar signs in tumors of the quadrigeminate plate. They often confuse the observer and lead to erroneous localization of the lesion, but the predominance of signs arising from anatomic alterations in the region of the quadrigeminate plate will lead the careful observer to the true location of the lesion.

CONCLUSIONS

1. Tumors of the quadrigeminate plate may be easily recognized by a series of clinical signs and symptoms which assume the character of a syndrome.

2. The quadrigeminate plate syndrome consists of three distinct groups of signs: (*a*) general signs, provoked by increased intracranial tension; these are likely to be marked because of the critical location of the tumor, and they include papilledema, headache, vomiting and dulling of the intellect; (*b*) local signs, caused by direct anatomic disturbances in the quadrigeminate plate and adjacent structures; these provoke disruption in the function of the extrinsic and intrinsic ocular mechanisms, ophthalmoplegias, Argyll Robertson pupil, paralysis of upward gaze, skew deviation, diplopia, the appearance of pyramidal tract and cerebellar signs and the occurrence of other manifestations of disease of the midbrain (tremor, postures, rigidities); (*c*) indirect signs, resulting from the effects of the tumor on distal areas of the brain; these are expressed in vegetative dysfunctions (polydipsia, polyuria, anomalies of skeletal growth and maldevelopment of secondary sex characters).

3. Clinical methods of examination (ophthalmologic and neurologic) yield sufficient information for the localization of these tumors, and mechanical aids in diagnosis are seldom necessary.

4. Tumors of the quadrigeminate plate, in the great majority of instances, present histologic features that place them among the neoplasms commonly called pinealoma.

MULTIPLE MYXOMA OF THE ORBIT

LATER NOTE *

S. R. GIFFORD, M.D.
CHICAGO

In 1926, a case of multiple myxoma of the orbit was reported.[1] The patient was a woman, aged 25, with ptosis and swelling under the right upper lid, limiting the motility of the eye upward. Incision through the brow revealed a group of shiny grayish bodies, resembling a bunch of grapes, just under the orbicularis. Seven of these were removed, each being apparently unconnected with the others or with other structures in the orbit. They were apparently removed completely, with a good cosmetic result. Sections resembled exactly the ones to be described, and the diagnosis was multiple myxoma (fig. 1).

Four years later, the patient returned with a history of recurrence, first noted eighteen months before. The eye was pushed down and out, and motion up and in was limited. Vision was normal, and the visual field showed no change. The exophthalmometer showed the right eye to be proptosed 5 mm.

Under general anesthesia, a large curved incision was made at the upper and outer borders of the orbit, and a large mass of tumors resembling those here described was exposed. These extended almost to the apex of the orbit, but were removed by blunt dissection without resection of bone. The largest resembled a white grub worm about 1 inch (2.5 cm.) long, the others being of various shapes (fig. 2). Ten separate masses were removed. There was no bleeding from the growths, and they apparently possessed only delicate connections with the orbital tissues, the probable connections of the largest growth being at the blunt end. The wound was closed without drainage, and the patient was discharged with a good cosmetic result. On account of the history of recurrence, radium needles were placed in the orbit.

Section of one of the moderate-sized nodules showed it to be composed of loose tissue. The characteristic cells were branched; spindle-shaped cells with long processes, the space between the fibrils containing an almost homogeneous material. The fibrils and a few granules between stained pink with eosin, and more fibrils became pink with van Gieson

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* From the Department of Ophthalmology, Northwestern Medical School.

1. Contributions to Ophthalmic Science, Menasha, Wis., George Banta Publishing Company, 1926.

stain. There was no capsule, the outer wall being a thin layer of fibrils. A few thin-walled vessels containing red cells were present. Some of the walls of the vessels showed a peculiar layer of homogeneous material just outside of the endothelium. Just outside of this there was another layer of spindle cells, which was probably a condensation of

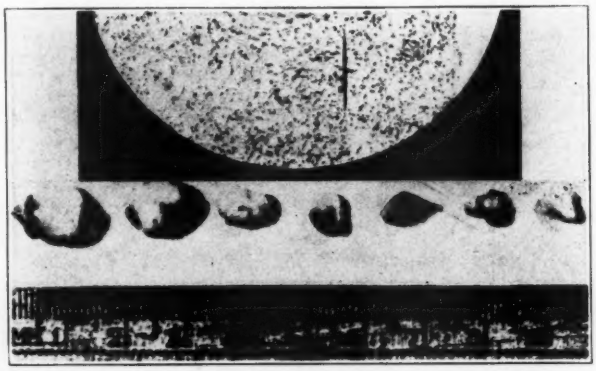

Fig. 1.—Tissue removed at previous operation, with low power photomicrograph of one of the nodules.

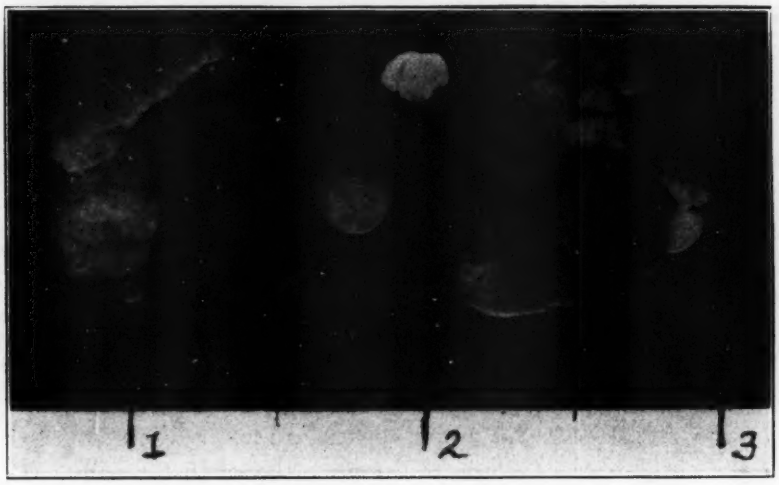

Fig. 2.—Tissue removed at last operation (scale in inches).

the growth surrounding the vessels. Some large and some small mononuclear cells were present.

Thionine stain (Hoyer) for mucin showed homogeneous blue-stained areas between the fibrils. These spaces remained unstained by the other methods. By this method many fine fibrils were also stained that were not shown by other methods, and these seemed to be unconnected with any nuclei.

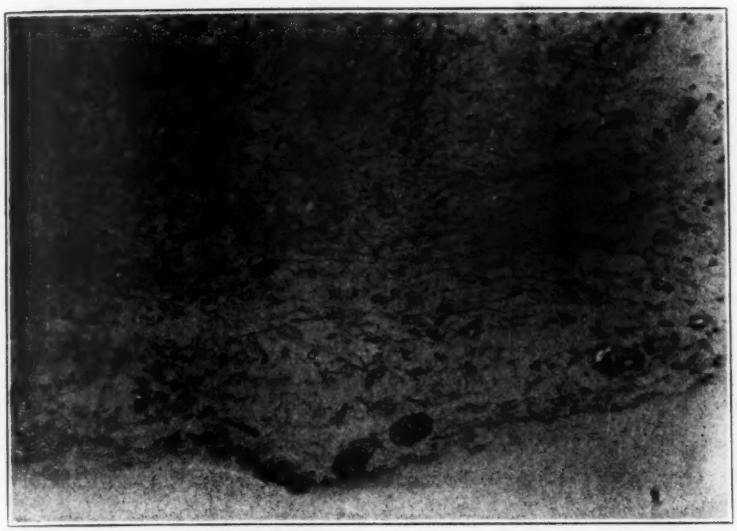

Fig. 3.—Low power magnification of one of the nodules; hematoxylin and eosin.

Fig. 4.—High power magnification of same nodule shown in figure 3; hematoxylin and eosin.

The van Gieson stain turned most of the fibrils pink. The fibrils connected with nuclei stained plainly with van Gieson stain, but the finer ones did not stain. Apparently the finer fibrils were composed of mucin, while the larger ones were processes of the branched connective tissue cells. The observations were identical with those in the tumors previously removed, and were considered characteristic of true myxoma.

These tumors are to be distinguished from mucoid degeneration of other tumors, such as gliomas of the optic nerve, and of certain edematous tissues of the nature of nasal polypi. Myxomatous tissue is found in mixed tumors of the lacrimal gland, but true myxomas of the orbit resembling those found in the present case are evidently exceedingly rare. The case of Wingenroth quoted in the previous report [1] is the only one found that at all resembled this. The complete independence of these growths in relation to the lacrimal gland, the usual source of tumors in this part of the orbit, should be emphasized. The recurrence in this case must be attributed to incomplete removal, one or more tumors having apparently been present which were too small to be distinguished from the rest of the orbital contents. Nothing in the structure of the tissue removed at either operation suggested anything but a benign growth.

OSSEOUS TUMORS OF THE ORBIT*

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Although bony growths within the orbit are relatively frequent, a review of the literature fails to produce a complete description of them from an ophthalmologist's point of view. For this reason we present two cases of bony growths of the orbit producing exophthalmos and other eye conditions, which we trust may contribute somewhat to the knowledge of this little studied aspect of ophthalmology.

It has been customary to consider nearly all new bony growths involving the skull and facial bones as Paget's disease. In his original description, however, published in 1870, Paget apparently did not try to classify these new bony growths in any way. If the new bone formation is limited to the bones of the skull, the term leontiasis ossea, as given by Virchow, would seem to be a better descriptive term to use.

In the so-called Paget's type of tumor growth, the bones concerned in the formation of the vault of the skull and the bones of the face are principally involved. This soft new growth of bone gradually acquires an ivory hardness. The bones of the skull take on a thickness that often becomes as great as 4 cm. (in one of the cases we present, 5 cm.) between the inner and outer tables. The bone cuts easily with a knife, and the bone-marrow loses its blood-forming element and becomes converted into vascular fibrous tissue. The architecture of the bone is disorganized, and the cortex loses its character and sharp outline. The marrow cavity itself is filled completely, and a thick subperiosteal layer is laid down. Cysts filled with fluid may form, and marble-hard exostoses of lobulated appearance are present. The potential space within the skull and the accessory nasal sinuses gradually become partly obliterated, and the fissures and foramina become more and more narrowed.

With this pressure and continually diminishing size of the skull cavity, foramina and orbits, it is easy to realize that headaches, cramps, paralyses, neuralgia, blindness and distortion of the sense of smell and hearing must gradually ensue. The hands and feet may hypertrophy.

It is interesting to note that pathologic new bone formation occurs in exactly the same way as physiologic growth does. The marrow

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periosteum, cartilage and connective tissue are the principal bone-forming structures. The actual bone producers are the osteoblasts, derived from the periosteum and endosteum of the marrow.

Paget's disease should be an obvious clinical entity which usually occurs in older persons (Stillings' patients were 70, 77 and 92 years of age, respectively); it leads to gradual increase of softness, to brittleness, with deforming thickenings of many parts of the skeleton but

Fig. 1.—Left eye prolapsed in primary position.

probably most marked in the tibia and skull, and, in advanced cases, to changes in height, posture and gait.

The terms osteitis fibrosa of Recklinghausen and osteitis deformans of Paget may be considered identical. They begin insidiously, accompanied by rheumatic pains, and tumor-like growths gradually appear. There is no halisteresis as in osteomalacia. The causative factors entering into this new bone growth are as yet undetermined, but trauma

and syphilis may enter as causative factors, and, as Da Costa in his work on Paget's disease brought out in 1915, there seems to be a retention of calcium, magnesium and phosphorus with excess excretion of sulphur; in spite of the softness of the bone, it is rich in calcium. In Paget's disease the first bone to be attacked is usually the tibia; the hands and the feet rarely enlarge as in acromegaly. The skull increases in diameter and appears too large, with a comparatively small face.

Fig. 2.—Though prolapsed, the eye can be rotated.

In his quest of the etiology of Paget's disease, Morpurgo found a gram-positive diplococcus, which led to the belief that Paget's disease might be of an infective origin. Further studies by others did not bear this out. Relations to the secretory function of various glands have been postulated, particularly the parathyroids, but thus far no definite theory has been brought forward as to their rôle in the etiology of new bone formation.

The original description of Paget's disease given by Paget in 1870 in his lecture on surgical pathology is interesting in this connection. He stated that compact, hard or ivory-like tumors occur, especially about the bones of the head, and present several diversities of form. Simple tumors are commonly attached to the skull by narrowed bases over which their chief masses are prominent on one side or all around. These tumors may consist of a hard exterior and a cancellous interior tissue, respectively, resembling and continuous with the outer table and the diploe of the skull. These may grow from either the outer or the inner table and may be multiple in the same skull.

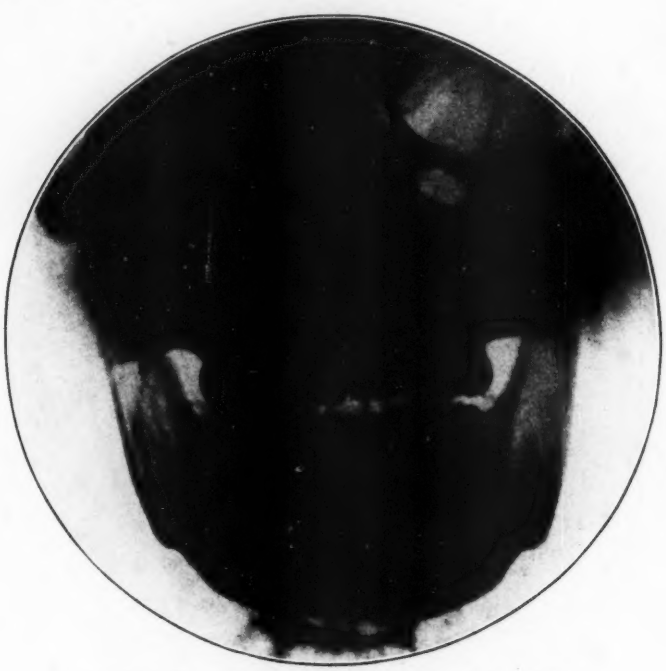


Fig. 3.—Osseous tumor filling the left antrum.

A disease much more formidable than these exists in the nodulated and larger hard osseous tumors connected with the bones of the skull. These are not like outgrowths from the outer table and diploe, for they often grow first between the tables of the skull or in the cavities of the frontal or other sinuses. Increasing in these parts, they may tend in every direction to penetrate the tables of the skull, forming huge masses projecting into the interior as well as on the exterior of the skull.

The most frequent seat of such tumors is in the frontal bone, especially about the orbital parts.

Several cases were described and all prove the general character and relations of these tumors. Their nodular form and uniform hard, ivory-

like texture, their growth on the diploe or sinuses as isolated or narrowly attached masses, their tendency to extend in all directions, their raising and penetrating the bones of the skull, and growing into the cavities of the skull and orbit show the exceeding peril of operations on them.

The simpler kinds that grow only outward may be cut off with advantage, though seldom without great difficulty, and often the attempt to remove them has been made in vain; but these larger and nodular tumors about the brow can rarely be either cut or extirpated.

Fig. 4.—Lateral view of osseous tumor.

These hard osseous tumors are rarely found with any bone but that of the skull. Paget has described several cases in which the hard, ivory-like osseous tumors have been found in the lower jaw.

In the texture of these hard bony tumors connected with the bones of the skull and the lower jaw, we may observe an instance of the general rule of likeness between tumors and the parts most near to them, much as in the internal table of the skull or the petrous bone or inferior maxilla.

REPORT OF CASES

CASE 1.—*History.*—H. L., a colored man, aged 55, was admitted to the Medical Service at Bellevue Hospital, Jan. 22, 1930, through the outpatient department, complaining of weakness and of having had "fits." He was seen a few days later by an attending ophthalmologist and was transferred to the eye wards for examination, observation and treatment.

We first saw the patient January 28, and obtained the following history: The patient stated that he had "fits," evidently epileptiform convulsions, every three or four months; that the first had occurred five years before and was just as severe at that time as the more recent ones. He stated that during these seizures he was unconscious for about ten minutes, and on waking was weak and sleepy. He often awakened and discovered that he had hurt his head or face, that his tongue was sore, and occasionally that he had bled from the mouth. Two years before, he first noticed that the left eye appeared larger than the right; since that time it had slowly grown forward.

The patient had had typhoid at 7 years. He stated that he had never had venereal disease.

His father had died many years before of tuberculosis. His mother died in 1907 of cardiorenal disease. He had two sisters and one brother. One sister had died at 17 years of tuberculosis.

Examination.—The patient appeared ill developed and undernourished; he was partially bald, and there were many scars of old lacerations over the head and face. The ears, nose and throat were normal. The tongue was scarred. The heart and lungs were normal; the vessels were sclerosed. The abdomen did not reveal any tenderness or glandular enlargement, and the extremities apparently were normal. The skin was dry and scaly.

Externally, except for chronic conjunctivitis, the right eye was normal. The left eye was proptosed straight forward, carrying with it the lids and adnexa. There was a definite thickening of the bony orbit at the lateral and inferior margins. The globe prolapsed easily and often did so spontaneously. Keratitis e lagophthalmo did not occur.

Vision in the right eye was 20/20 and in the left eye 20/200. There was orthophoria for distance and near vision, and both globes moved freely in all directions of gaze. Diplopia was not demonstrable.

With the exophthalmometer the right eye measured 20 mm. and the left eye 26 mm. When prolapsed, the left eye measured approximately 28 mm.

The fields were normal in both eyes. The normal field of the left eye was plotted with the eye prolapsed.

Tension in the right eye was 14 and in the left 16 with the Schiötz tonometer. In the prolapsed left eye it was 22.

With refraction under homatropine, retinoscopy showed: right eye +1.25 and left eye —.75.

Acceptance was: in the right eye, 20/20; in the left eye, with a —1.75 sphere, 20/20—, and in the prolapsed left eye, with a —2.00 sphere, 20/20.

The fundus of the right eye showed mild sclerosis of the retinal vessels; otherwise it was normal. In the fundus of the left eye there was mild sclerosis of the retinal vessels; the retina and papilla were normal in color, and the macular region appeared normal. The physiologic cupping was deep, and if the globe was prolapsed while the cupping was being examined, it appeared to become deeper.

The two eyes transilluminated equally well from all angles.

Laboratory Examinations.—The Wassermann reaction of the blood was negative. The spinal fluid Wassermann was 4 plus. The colloidal gold curve was 44332100. Tests for sugar and globulin were negative. There were 10 cells per cubic millimeter.

Roentgen examinations were performed in Bellevue Laboratory. In the skull there was obliteration of the upper portion of the left maxillary antrum by a

dense mass, a possible osseous neoplasm forming an integral part of the malar bone and the anterior wall of the maxillary antrum. Examination of the orbits revealed normal optic foramina, the left apparently surrounded by dense osseous tissues. Reexamination of the skull resulted in a duplication of this report.

The roentgenogram of the chest showed adenopathy at the roots of both lungs and moderate aortitis.

The dorsal and lumbar spines were normal.

Fig. 5.—Anterior view showing ptosis of left upper lid, tumor mass in left frontal region and asymmetry of face.

The right ischium showed irregular bone sclerosis with circumscribed areas of bone atrophy. The ascending ramus of the ischium was increased in size. The remainder of the pelvis was free from pathologic change.

The distal extremities were normal.

The roentgenologist's report suggested early Paget's disease. Our impression was that the condition was exostosis of the left orbit producing unilateral exophthalmos with spontaneous prolapse. We believed that this was a case of later acquired deformation of the orbit due to inflammatory or neoplastic swelling in the bones or sinuses, and that the maxillary antrum was the seat of greatest

involvement. According to Herbert Parsons, "ectasia of the maxillary antrum by inflammatory processes scarcely ever produces exophthalmos." Roentgenograms showed involvement of the orbital floor and the temporal wall. Ectasia of the sphenoidal sinuses was also difficult to diagnose. The history of epilepsy and the physical observation of scars about the head, particularly the two linear scars over the malar bone near the orbital margin, supported traumatism as an important factor, etiologically, in the origin of the exostosis. Repeated examination did not reveal pulsations or bruits.

CASE 2.—*History.*—A. S., a woman, aged 30, unmarried, of Italian parentage but born in the United States, was admitted to the eye department of the Vander-

Fig. 6.—Anteroposterior view showing extent of osseous growth.

bilt Clinic, Feb. 25, 1929. When a child, the exact age being unknown, the patient fell and a large bony growth developed in the right frontal region. She was operated on twice for the removal of this bony overgrowth. Unfortunately, it was impossible to obtain the record of the surgeon who operated, but in spite of the fact that bone had apparently been removed from the left frontal region seventeen years before, she had always since had a protruberance at this region; recently the left eye had been more prominent than the right, and the vision of that eye had gradually diminished. She had consulted no other physican since the time of her operation, and, with the exception of a dull headache occasionally, had not been inconvenienced. For the past week, however, the headache had been more pronounced and not well localized, but apparently had a more frontal character.

The family history was not important; the father, mother, a brother and two sisters still being alive and well. The patient had had no diseases, with the exception of scarlet fever and measles as a child. Otherwise her general health was good.

Physical Examination.—The vision of the right eye was 20/50 + 2 and that of the left eye 20/200. Under homatropine vision could not be improved with lenses. The muscles, screen and parallax tests showed an exotropia of 15 degrees for distance and 20 degrees for near vision. She also had a right hypertropia of 20 degrees for distance and 10 degrees for near vision. There was marked ptosis of the left upper lid, and the veins of the left lid were dilated and engorged. Both corneas showed many nebulae. The lenses were clear. The right disk was of good color, but the margin was rather indistinct. The left disk, however, was very pale. The veins and arteries showed no abnormalities.

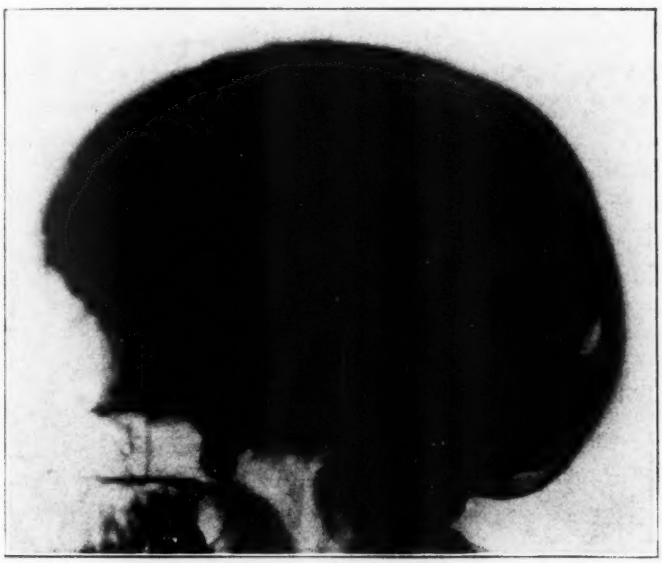


Fig. 7.—Lateral view of dense bone formation, showing obliteration of sella turcica.

Roentgen examination by Dr. Golden, including stereoroentgenograms of the skull in both lateral positions and with the brown down, showed an enormous increase in the thickness and marked irregularity in the density of the left side of the frontal bone and the anterior part of the parietal bone. The process was possibly a little to the right of the midline. The distance from the outer margin of the outer table to the inner margin of the inner table, just above the eyes, was 5 cm. At the vertex it was about 2.5 cm. The floor of the anterior process was enormously increased in density and in thickness. The sphenoid seemed to be involved. The sella was small and pointed. Its dorsum was thick. In the region of the sphenoid, the density of the bone was homogeneous. Elsewhere the skull appeared normal. The marked increase in the thickness of the bone had apparently deformed the left orbit, had pushed the nasal septum considerably to the right, and seemed to have filled up the greater part of the left nasal passage. This, we think, was Paget's disease.

The exophthalmometer readings were: right eye 16 mm. and left eye 21 mm.

Roentgenograms of the spine and of the pelvis and extremities showed none of the characteristic changes of Paget's disease. Films of the hands and feet disclosed nothing abnormal.

Wassermann reaction of the blood was negative. The blood calcium was 14.2 mg. per hundred cubic centimeters. With the exception of the involvement of the sinuses by the new bone growth formation, examination of the nose and throat did not reveal any abnormalities in the throat or pharynx.

An examination by the endocrinology department at the Neurological Institute showed nothing suggestive. Parathyroid extract-Collip, 7 minims (0.4 cc.), was given hypodermically three times a week, and sodium iodide, 5 drops, was given three times a day together with thyroid extract, ½ grain (32 mg.), twice a day.

The distinctive features in this case of leontiasis ossea were the marked thickening of the roof of the skull and the new growth of bone into the left orbit and into both antrums, the frontal sinuses, the nasal cavity and the ethmoids and sphenoidal regions, giving the patient severe headaches, a partial loss of vision, exophthalmos and a muscular imbalance. The ptosis itself was probably caused by the removal of part of the bony growth of the forehead in her youth. It is also to be noted that in this case the calcium content of the blood was high, as was found by Da Costa in his series of cases of osteitis deformans. It would seem, however, that this case should be classified as one of leontiasis rather than an osteitis deformans (Paget's disease), for in this case the only bones involved were those of the skull, and there was no involvement of the other skeletal bones such as would be found in Paget's disease. It should also be borne in mind that in this case the new bony growth developed early in youth, whereas Paget's disease is usually a disease of adult life or occurs in the aged.

SUMMARY

Although, during the past sixty years since Paget first described bony growths of an unknown origin, many cases have been reported and undoubtedly a great number have been seen though not reported which could be classified as osteitis deformans, ophthalmologic literature appears to be barren when one reviews these types of cases. The two cases that we have presented are manifestly in their symptoms and from the diagnostic standpoint truly within the field of ophthalmology, as the new-formed bone primarily affects the orbit and its contents, although the cranium and the accessory nasal sinuses are involved to a lesser degree.

Consequently it is not to present anything new regarding the etiology, symptomatology, diagnosis or treatment that we report these cases, but if possible to draw the attention of those interested in diseases of the eye to this strange and insidious disease process. Most of the writers, with the exception of Virchow and his followers, seem to believe that

new bone growth of the bones of the head, regardless of whether or not any of the other skeletal bones are affected, should be classified as osteitis deformans. It would seem to us, however, that a differentiation should be made in those cases which occur early in life and which for years are nonmalignant, although they may become malignant, and which in no way affect gait or posture but only mechanically affect the head and its cavities, from those which come as a rule later in life and involve a number of nonrelated bones. These cases open up a wide field for investigation, as to both etiology and treatment, and we present this as a preliminary report. After more careful study, both of the cases that we now have at hand and of those that we hope to see in the future, we intend to present the results of further study as to etiology and treatment.

30 West Fifty-Ninth Street.

ABSTRACT OF DISCUSSION

DR. ARNOLD KNAPP, New York: I shall limit my remarks to the partial hyperostoses of Naito, as the two cases reported by Ellis and McKeown, in my opinion, belong to this variety. I have observed three cases of partial hyperostosis: The ages of the patients were 38, 46 and 43 years, respectively. The exophthalmos was marked, varying between 5 and 9 mm. A bony mass could be palpated within the outer bony wall. The optic nerve showed a neuritic optic atrophy. The vision was 6/9 and better. In all three cases the roentgenogram demonstrated hyperostosis: increased density of the greater wing of the sphenoid and of the horizontal portion of the frontal bone. In one there was in addition a slight involvement of the malar and ethmoid regions, and in another the swelling of the outer orbital wall also extended into the temporal fossa. There was no change in case 1 in six years; case 2, in which the hyperostosis was present both in the orbit and in the temporal fossa, has been followed for eight years. An operation was attempted in which the bony mass bulging into the orbit was removed. Though this for a time reduced the exophthalmos, the condition subsequently returned and distinctly increased in size. I feel that the operation was ill advised and possibly increased the normal growth. Case 3 has been under observation for one year. This condition of partial hyperostosis is a remarkable and interesting one. Its changes are definite. The underlying pathologic process is not understood.

DR. GEORGE M. CONSTANS, Bismarck, N. D.: I have been working on this subject for a number of years from the standpoint of the etiology and pathology of bony tumors of the orbit, although as yet the results have not been published. As the authors state, these growths are relatively frequent, but compared with the total number seen, these true bony growths of the orbit are not common, although small growths without symptoms and in the absence of roentgen examination may easily be overlooked. Ordinarily, the diagnosis is not difficult and roentgen examination is conclusive evidence of their presence. Ophthalmologic signs and symptoms are those common to any tumor of the orbit, and the treatment is chiefly a mechanical problem dealing with their surgical removal, often a difficult procedure.

I cannot agree with the author's mode of grouping these tumors. They are not a manifestation of Paget's disease, nor yet are they types of leontiasis ossea; they are instead true bony tumors of the orbit. The hyperostoses are not true

tumors but merely the result of diffuse thickening of the affected bone as in leontiasis ossea. I agree with Dr. Knapp that the cases reported belong in this group.

Dr. John Green, St. Louis: Fifteen years ago I made a study of the ocular complications in leontiasis ossea. My interest in this subject was aroused by the observation of a case of leontiasis ossea in which there was marked exophthalmos and wide separation of the globes. The patient had a serious deformity of the cranium. There were large bosses in the temporal, occipital and parietal regions. In a review of the literature it appeared that the degree of exophthalmos was variable, ranging from the slightest protrusion to a condition in which the deformity was hideous in the extreme and surgical measures were demanded to reduce the degree of exophthalmos. The last speaker asserted that thickening of the bones in leontiasis was a diffuse thickening. I hardly believe that this can be true in all cases because of the presence of large bony bosses on the skull. It seems proper to assume that the orbital involvement is of the same nature. My patient has slowly improved year by year. To what this improvement may be ascribed it is impossible to state with certainty. The patient gave a negative Wassermann reaction. There was a suspicious history of syphilis in the parents. The patient has been under low doses of mercury day in and day out for the last twenty years. The exophthalmos is much less, the separation of the eyes, which was enormous, the original interpupillary distance being 83 mm., is reduced to about 75 mm., and the patient is fairly comfortable.

News and Notes

GENERAL NEWS

Eighth Postgraduate Course in Ophthalmology, Vienna, 1931.—The eighth special course for postgraduate study in ophthalmology will be given between Oct. 1 and Dec. 3, 1931, under the auspices of the American Medical Association of Vienna at the First and Second Eye Clinic of the Allgemeines Krankenhaus, Vienna, Austria. Prof. J. Meller and Prof. K. Lindner, chiefs of the Eye Clinics, have again consented to take an active part. The other lectures will be given by Prof. A. Fuchs and Docents Bachstez, Guist and Pillat, and assistants of other departments will deliver lectures in their respective subjects.

The course has been so arranged that the field can be covered systematically and comprehensively in the allotted time. A preliminary knowledge of ophthalmology is presupposed. Concerning operations only lectures with demonstration will be given, and in refraction only advanced work will be done. The entire course is given in English for a minimum of ten, and a maximum of sixteen, persons. The fee is $250 per student. Applications with a certified check for $100 should be sent to Prof. A. Fuchs, Vienna, VIII, Skodagasse 13, and are accepted in order or priority. Further information can be secured by writing to Prof. Dr. A. Fuchs, or to the American Medical Association, Vienna, VIII, Alserstrasse 9, Cafe Edison.

Ukrainian Ophthalmological Journal.—An issue of the Ukrainian Ophthalmological Journal has been received. This quarterly journal is edited by Prof. P. Prokopendo and is published in Charkov. It is the organ of the Ukrainian Department of Scientific Institutions, and of the People's Commissariat of the Public Health of Soviet Russia. The articles are published in Ukrainian, but fortunately a brief summary in German is frequently appended.

Course for Ophthalmologic Residents.—This course was given by members of the various university clinics and hospitals in Chicago for the benefit of ophthalmologic residents of that community. The course was completed in November with a banquet and a talk by Dr. William Wilder on ophthalmic ethics. The attendance at the course was good, most of the twenty-three residents being present at every lecture. The course will be repeated in 1931.

Preliminary Notice.—The Annual Congress of the Ophthalmological Society of the United Kingdom will be held in the Anatomical Institute of University College on April 23, 24 and 25. The subjects chosen for discussion are: (1) Affections of the Eye Due to Viruses, and (2) The Rôle of Vision in Sport.

Klinische Monatsblätter für Augenheilkunde.—This publication will be continued by the following men, all former assistants of Axenfeld: Professors A. von Szily, W. Stock and E. Engelking, and Dr. B. Kayser.

UNIVERSITY NEWS

A graduate course in ophthalmology to last one year, commencing September, 1931, is being planned by the various university eye clinics and by the hospitals that have an eye service in Chicago. Some of the cooperating institutions will be the University of Chicago, Northwestern University, Rush Medical College, Loyola University, Cook County Hospital, Michael Reese Hospital, St. Luke's Hospital and the Illinois Eye and Ear Infirmary. It is planned to accept twelve students who are graduates of Class A medical schools, and diplomates from a general internship. There will be about 500 hours of didactic work and 1,000 hours of clinical work, in rotation in the various clinics. Dr. Richard Gamble, 30 North Michigan Avenue, is secretary for the course, and will receive applications for admission.

SOCIETY NEWS

Chicago Ophthalmological Society.—The society held its annual meeting on January 19. A reception before the meeting was held for Dr. Harvey Howard of St. Louis, the guest speaker, who outlined his plans for a Research Institute in Ophthalmology.

Obituaries

SAMUEL THEOBALD, M.D.
1846-1930

Samuel Theobald died on Dec. 20, 1930. He was a member of one of the most interesting medical families of this country. His great-grandfather, Nathan Smith (1762-1829), founded the medical schools of Dartmouth, Yale, Bowdoin (Maine) and Burlington (Vermont), and taught various branches of medicine in all of them, though his name is especially associated with Yale, where he was the first professor of physic, surgery and obstetrics.

Of Nathan Smith's four sons, all physicians, Nathan Ryno (1797-1877) was the most distinguished as teacher and as surgeon. He helped his father to found the school at Burlington, where he taught; he aided in founding Jefferson Medical College, and taught for several years at the Transylvania Medical School in Kentucky; but it was as professor of anatomy and of surgery at the University of Maryland that he achieved his greatest reputation. His pupil, Professor Gross, described him as "one of the most extraordinary men whom this country has produced." In Maryland, he was known as the "Emperor." He was Samuel Theobald's grandfather.

Two of Nathan Ryno's sons became physicians: Berwick (1826-1860), who taught anatomy at the University of Maryland but died while young, and Alan Penniman (1840-1898), who distinguished himself as professor of operative surgery at the University of Maryland, and is credited with having inspired Johns Hopkins to found the hospital that bears his name. Dr. A. P. Smith was a charter member of the board of trustees of this hospital and served until his death. [Dr. Nathan Smith Lincoln (1822-1898) of Columbia University, Washington, D. C., was also a grandson of Nathan Smith.] Two sons of Alan became physicians, Nathan Ryno, Jr. (1863), and Walter Prescott (1868-1902). A daughter of Nathan Ryno, Sarah Frances, married Dr. Elisha Warfield Theobald (1818-1851), and their sons, Samuel and Elisha Warfield, Jr. (1850-1877), likewise followed the medical profession. [Dr. Warfield Theobald Longcope, the present professor of medicine of Johns Hopkins, is the son of Dr. Samuel Theobald's sister.]

Dr. Samuel Theobald was born in Baltimore on Nov. 12, 1846. Owing to the early death of his father, he was brought up in his grandfather's home, and thus in his childhood came under the powerful influ-

ence of his grandfather, for whom he always showed the greatest affection, reverence and admiration. Under his grandfather's guidance and as his "office student," he took up his medical course at the University of Maryland and obtained his degree at the age of 22. After graduation, Dr. Theobald married Miss Caroline Dexter DeWolf, and then spent several years abroad in the study of diseases of the eye and the ear. It is of interest to mention that his grandfather, like the surgeons of his period, included ophthalmic and aural surgery in his practice. To

SAMUEL THEOBALD, M.D.
1846-1930

the end of his life, Samuel Theobald cherished the instruments that his grandfather had used, many of which he, too, was fond of using and of showing to his medical friends.

In Europe, Dr. Theobald studied under that remarkable galaxy of surgeons and teachers in London and Vienna, Bowman, Critchett, Jonathan Hutchinson, Soelberg Wells, Arlt, Jaeger, Politzer and others. On his return to Baltimore, in 1871, he entered the practice of the aforementioned specialties. In 1874, he established the Eye and Ear Dispensary, and in 1882, together with the late Dr. Russell Murdoch and others, he founded the Baltimore Eye, Ear and Throat Charity

Hospital. He continued active association with this institution until a few years before his death.

When the Johns Hopkins Hospital was opened in 1889, Dr. Theobald was appointed ophthalmic surgeon, and a few years later, with the establishment of the medical department of the University, he was appointed to the chair of ophthalmology, which he held until 1925. He participated actively in the medical meetings of the city and the state, and contributed many papers to the local ophthalmological societies, and especially to the American Ophthalmological Society, of which he was a member for fifty years, and president in 1910.

Dr. Theobald was an accurate observer, careful, painstaking and thorough in his examinations. He was one of that group of American ophthalmologists who made the study of errors of refraction an accurate art. He was a skilled operator. As a consequence, he had a large practice during a great number of years, and enjoyed the esteem of the public as well as of the members of the entire medical profession. He was elected president of the Medical and Chirurgical Faculty of Maryland (the state medical organization) in 1900. His name is especially associated with probes of large size, which he introduced in 1878 and with which he had great success in the treatment of lacrimal obstructions. He is also especially remembered for his well known textbook, "Prevalent Diseases of the Eye," published in 1906.

Dr. Theobald was an ophthalmologist of eminence because of his native ability and skill, his personal charm, his splendid training, his careful study throughout his medical career and his conscientious devotion to his profession. He followed the best traditions of medical practice and its highest ethical standards. His relations to his patients, to his students and to his colleagues were characterized by the mildness, the courtesy and the amiable kindness of the perfect gentleman and physician. He was in truth the natural product of a family devoted through generations to the best medical ideals.

Dr. Theobald was able to continue his active work until he had attained his eightieth year, when the infirmities of age came on him almost with suddenness.

His devoted wife died in 1929. He is survived by three children, Mrs. John E. Lloyd, of Chicago, Mrs. Williams, the wife of Prof. J. Whitridge Williams of Johns Hopkins University, and Samuel Theobald, Jr.

The members of the medical profession of Baltimore take pride in the life and work of Dr. Theobald and of his illustrious family.

HARRY FRIEDENWALD, M.D.

HIRAM WOODS, M.D., LL.D.

1857-1931

In the passing of Hiram Woods on Jan. 15, 1931, ophthalmology and humanity sustained a grievous loss.

Dr. Woods, son of Hiram Woods, Jr., and Helen Chase Woods, was born in Baltimore on Nov. 11, 1857. After preliminary education in a private school in Baltimore, he entered Princeton University in 1875, and graduated in the class of 1879, which included a number of famous men, among them, Woodrow Wilson. He preserved a close friendship with his college mates throughout life.

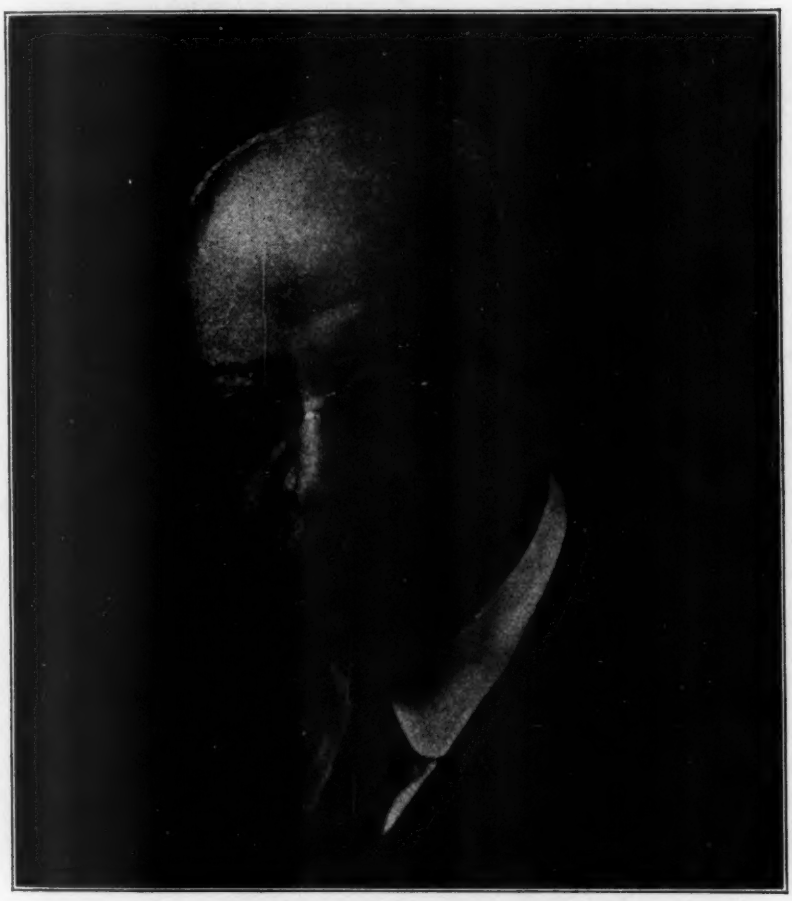
From 1879 to 1880, Dr. Woods took a special course in biology at Johns Hopkins; and in 1882 he graduated in medicine at the University of Maryland. After the close of his internship at Bayview Hospital in 1883, he was connected with the departments of medicine and dermatology at the University Hospital for three years. From 1885, Dr. Woods confined his practice to ophthalmology and otology, though he acted as demonstrator of anatomy at his medical alma mater until 1888. From 1887 to 1894, he was professor of ophthalmology and otology at the Woman's Medical College, Baltimore (now closed). From 1894 to 1920, he was lecturer and professor of ophthalmology and otology at the University of Maryland, and in 1924, this university conferred on him the honorary degree of LL.D.

Dr. Woods held many important professional positions in Baltimore; among them were: surgeon at the Presbyterian Eye and Ear Hospital until 1917, and ophthalmic surgeon at the Union Protestant Infirmary, Hospital for the Women of Maryland. He was consultant at the Sheppard and Enoch Pratt Hospital and at the Washington County Hospital.

He held membership in many scientific societies. He was president of the Medical and Chirurgical Faculty of Maryland, 1906, and chairman of its council for several years; chairman of the Section on Ophthalmology of the American Medical Association, 1912; president of the American Ophthalmological Society, 1919; and a member of the American Board of Ophthalmic Examinations from 1915 to 1920, and again from 1925 to 1926. He was a member also of the Baltimore City Medical Society, Southern Medical Association, American Otological Society, Academy of Ophthalmology and Oto-Laryngology and a fellow of the American College of Surgeons.

His contributions to ophthalmology showed close observation and great practical common sense. He was a constant attendant at the sessions of his scientific societies and always joined in the discussion of the topic forcibly and with conviction.

Dr. Woods was intensely interested in all matters pertaining to the protection of the people from blindness. For a number of years he was one of the directors of the National Society for the Prevention of Blindness and a very active member of the Maryland Society for the Prevention of Blindness. A meeting of the latter society at his office had been called for the day of his death. In the last twenty-four years he had missed only two meetings.



HIRAM WOODS, M.D., LL.D.
1857-1931

He was a member of the First Presbyterian Church of Baltimore, and served faithfully for many years on its board of trustees. He was affiliated with the Phi Kappa Psi and the Nu Sigma Nu fraternities and the University Club, of Baltimore.

A happy event in Dr. Woods' life was his marriage on Oct. 28, 1886, to Laura Hall, daughter of the late Robert C. and Mary Hall of Balti-

more—a fortunate union that lasted more than forty years. For several years Dr. Woods had not been strong physically, though his mind had never been more active. Pneumonia, that "foe of youth, but the friend of age," gently removed from us our beloved friend. He is survived by his wife, four children and nine grandchildren. He had the great delight of seeing his only son following successfully his illustrious footsteps.

For forty years the name of Hiram Woods has been closely bound with the history of ophthalmology in the United States. It is impossible in any space, much less in a limited one, to do justice to this great humanist. Ex-President Wilson, whom the world called cold and aloof, had a warm place in his heart for his old classmate, "Hi Woods." Honest, courageous, observing, painstaking ophthalmologist, we have for him in our hearts and in our minds, the memory of a good citizen, a loyal friend and a man devoid of self love—"monumentum aere perennius."

W. H. WILMER.

E. S. THOMSON, M.D.
1871-1931

Dr. Edgar Steiner Thomson was born at Mount Savage, Md., on Dec. 18, 1871, the son of Dr. Alexander Thomson, who was a surgeon in the Federal Army during the Civil War, and died on Jan. 12, 1931. He came of a distinguished family.

Dr. Thomson was educated in the public schools of Allegheny County, Pennsylvania, and by private tutors. He was graduated from the University of Pennsylvania School of Medicine in 1893. He then became an intern at Kings County Hospital, and on finishing that service became a member of the House Staff of the Manhattan Eye, Ear and Throat Hospital of New York. Here he served as assistant surgeon from 1895 to 1902, when he became director of his clinic, as well as a director of the hospital. He was professor of ophthalmology at the Manhattan Post-Graduate Medical School and at the New York Polyclinic Medical School and Hospital for many years.

During the World War he was commissioned a major, and served at U. S. General Hospital No. 1 in New York. Dr. Thomson was consulting ophthalmologist of the New York Babies Hospital, the Englewood Hospital, the Perth Amboy Hospital, the Ossining Hospital and the Bronx Eye and Ear Infirmary.

His professional writings were many. He was a fellow of the American Medical Association, having acted as secretary and vice-chairman of its Section on Ophthalmology; a member of the American Ophthalmological Society and of the New York Academy of Medicine, and a member and one time president of the New York Ophthalmological Society. He was a leading ophthalmologist, and took great pride and interest in his work.

He was an enthusiastic student of geology and archeology, and made many trips through the western part of our country, besides visiting Europe a number of times. He took great interest in music and the stage. While in his teens he began the study of the violin, and early organized a string quartet in which he played the first violin. This string quartet played every Friday night during the fall, winter and spring for thirty-seven years, playing the works of Brahms, Beethoven and Mozart and of the more modern composers. Edgar Thomson's knowledge of musical literature was extensive, and his appreciation of music was outstanding.

He was a simple, straightforward man, who always believed in facing life squarely, but with a gentle, quiet smile. He understood other people's difficulties; no one ever went to him for sympathy or help and came away empty-handed or uncomforted. His wonderful heart and mind will live in the memory of his friends forever.

H. W. Wootton.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Conjunctiva

A CASE OF OCULOGLANDULAR TULAREMIA (PARINAUD'S CONJUNCTIVITIS). ARNE BRYN, Klin. Monatsbl. f. Augenh. **85:** 61 (July) 1930.

Three cases of tularemia which occurred in Norway were reported by Thjoetta in February, 1930, in the *Norsk Magasin for Lægevidenskaben.* Thjoetta's new agglutination test allows a definite distinction between tuberculous conjunctivitis and tularemia, which seems to form one group with Pascheff's and Parinaud's conjunctivitis.

Bryn reports the case of a man, aged 30, who, when eviscerating (drawing) a hare after hunting, felt blood from the animal touching his right eye; he wiped the eye with his kerchief. The lids were swollen, and abundant discharge appeared a week later. Fever developed during this time. The conjunctiva was swollen but free from ulcers, necrosis or any other efflorescences except a small number of nodules the size of a pinhead. These were of the same dark red hue as the conjunctiva, and some of them were slightly ulcerated at their apex. The fornices were free, and no bacteria were found in the discharge. The preauricular and submandibular glands were tender to touch, and pain was caused by opening the mouth. The patient felt fatigued and had muscular pain. The urine was normal. This case of tularemia was of the oculoglandular type. The first reaction to the agglutination test, made about the tenth day, was negative, while the second, made three weeks after the onset of symptoms, was positive. A culture of *Bacterium tularense,* received from the United States, was used. The glands increased in size during the course of the disease, and papules developed on the hands. The patient had fever for about three of the six weeks of his illness. A number of other cases of tularemia, likewise due to infection by hares, occurred in the same district.

K. L. STOLL.

Cornea and Sclera

SUPERFICIAL PUNCTATE KERATITIS. R. E. WRIGHT and CO-WORKERS. Brit. J. Ophth. **14:** 595 (Nov.) 1930.

The epidemic described lasted until February, 1930. By the end of 1929, about 3,500 cases had come under observation. The character of the disease appeared to change considerably. The external signs were more severe. Throughout the epidemic males were more susceptible, and there was a marked escape at early ages. Experimentally, the incubation period was between three and nine days. There was no acquired immunity. One eye was as frequently attacked as the other. This condition was likely to be confused with simple catarrhal conjuncivitis, familial dystrophy and conjunctivitis due to irritants.

In one case, there was an unusual corneal opacity. In the superior temporal quadrant, there were six horsehoe-shaped opacities capping

the apexes of vascular arcades. Corneal sensibility returned to normal. In two cases, the preauricular glands were enlarged.

No organism has been seen or cultivated which might be regarded of etiologic importance or identical with the organism described by Herbert in the Bombay epidemic.

W. ZENTMAYER.

CONTACT GLASSES WORN FOR SIX YEARS IN A CASE OF KERATOCONUS. H. LAUBER, Klin. Monatsbl. f. Augenh. **84:** 558 (April) 1930.

At the meeting of the Vienna Ophthalmologic Society on Feb. 17, 1930, Lauber reported on the case of a man who had worn the same contact glasses over both eyes since December, 1923. His vision could be brought up to 6/12 in the right eye, and to 6/10 in the left eye. He was able to graduate as engineer and is now teacher of mathematics and physics; he wears his glasses all day. The keratoconus of his left eye remained unchanged; in the right eye the opacity at the vertex of the keratoconus increased slightly.

Three other patients afflicted with a high degree of myopia were also helped considerably by using contact glasses. An opera singer and an actor wear them during performances and a young lady received them to enable her to see the goal during a swimming contest.

K. L. STOLL.

Experimental Pathology

A STUDY OF THE CORRELATION BETWEEN THE BIOCHEMICAL AND INTRAOCULAR CHANGES INDUCED IN RABBITS BY THE ADMINISTRATION OF NAPHTHALENE. D. R. ADAMS, Brit. J. Ophth. **14:** 545 (Nov.) 1930.

This lengthy paper is of special interest to the research workers along these lines. The study includes the variation in certain normal constituents of the blood after the administration of naphthalene; variations in the blood cholesterol; variations in blood calcium; the metabolism of naphthalene and the action of its derivation, and the excretory products of naphthalene.

The author states that the absence of any definite conclusions at this stage of the investigation is due to the necessity of following up so many different aspects of the problem. It is hoped that further work will bridge the gaps between these and will provide an adequate explanation of the action of naphthalene. There may be some significance in the fact that the development of the retinal exudates is accompanied by a fall in serum calcium, whether they are due to naphthalene or quinoline.

W. ZENTMAYER.

EXPERIMENTS ON THE HYPOTONIA CAUSED BY CONTUSION IN RABBITS. KARL SCHMIDT and J. F. DE DECKER, Arch. f. Augenh. **102:** 700 (Feb.) 1930.

Weights ranging from 60 to 100 Gm. were dropped from a distance of 1 meter on the eye with lids closed. Following this, the tension in both eyes was taken at frequent intervals with the tonometer. The typical curve shows an immediate drop in intra-ocular pressure following

the contusion, followed by a sharp rise. This persists for about ten minutes and is followed by a fall in the pressure below normal, which persists for twenty-four hours or longer.

The authors attempt to explain the various changes in the pressure curves on the basis of changes in the state of constriction or dilatation of the vessels. They refer to the work of Magnus, who showed that the usual reaction of the vessels in the frog's skin to moderate stimuli was dilatation, but that if the stimulus was of severer grade the opposite occurred, namely, a vasoconstriction. Attempts to determine the state of the vessels after contusion by the usual anatomic or histologic procedures were unsuccessful. The work of Leplatt (*Ann. d'ocul.*, vols. 161, 162) is referred to, but the present authors could not convince themselves of any marked differences in the appearance of the vessels between the control eye and the experimental eye. Likewise, attempts at weighing the enucleated globes gave no constant results.

They then investigated the effects of subconjunctival injections of various drugs, for example, barium chloride. They found that 0.3 cc. of a 1 per cent solution of barium chloride injected under the conjunctiva of an eye which was in the hypotonic state following contusion resulted in a return of the tension to normal or even a slight transient increase in pressure. Since barium chloride is known to act on the smooth muscle of the wall of the vessel, they conclude that the state of hypotonia following the contusion was due to all the intra-ocular blood vessels being dilated.

The analysis of the course of events following contusion is as follows:

1. The initial fall in pressure when the weight strikes the eye is due to pressing fluid out of the eye.

2. The rise in pressure is due to a vasoconstriction as described by Magnus. This vasoconstriction causes an increase in the tonus of the wall of the vessel (Steigerung der Gefässwandspannung). This leads to an increase in intra-ocular pressure. [No clear explanation is made of how this occurs.]

3. They regard the final fall in pressure as due to complete relaxation of all the vessels in the eye. The only evidence of this is their experiments with barium chloride and an analogy which they draw between their work and that of Magnus. [They do not mention the possible effects of barium chloride on the smooth muscle in the orbit.]

F. H. ADLER.

EXPERIMENTAL INVESTIGATION CONCERNING THE ACTION OF FOREIGN PROTEINS ON THE NORMAL EYE. A. VON SZILY, Klin. Monatsbl. f. Augenh. **85**: 21 (July) 1930.

After perusal of the literature on the treatment with serum and proteins, the author stated that the clinical and therapeutic considerations received more attention than the research on the pathologic and pharmacologic action of these bodies. He, therefore, performed a large number of experiments on rabbits for the purpose of studying the action on the normal eye of milk and milk preparations; he applied the intravenous, intramuscular and intradermal methods. Single injections of

from 1 to 2 cc. produced fever, epiphora and contraction of the pupils. After repeated injections or single, larger doses, actual inflammation of the anterior portion of the globe set in. As an exception, the author mentioned that a single dose of pyrifer, strength 7, was followed after twenty-four hours by iritis with posterior synechiae and deposits on the iris and Descemet's membrane. The clinical symptoms were transient, but could again be elicited in the same animal by repeated injections. Individual differences were observed in the reactions of the animals.

The author gathered from his experiments that the local and general symptoms are not brought on by the preparations themselves, but by reactive substances which form in the body after the injections. Small, white and well defined spots were found more frequently in the choroid than was actual inflammation of the anterior portion of the globe. These spots developed after from eighteen to twenty-four hours, and disappeared after some time, leaving pigmentation in only a few instances. Histologic examination revealed dilatation of the choroidal vessels, increase in the number of the leukocytes with formation of nests of leukocytes and diffuse infiltration in almost every case. Infiltration of the chamber angle by leukocytes and lymphocytes was frequently seen. The ciliary body was most distinctly involved. This is significant, considering the importance of the ciliary body for the nutrition of the eye. Von Szily found an increase in the albumin even after the intramuscular injection of milk, the least active of these so-called irritant substances.

The symptoms of inflammation produced by the injections are followed by the phase of the desired inhibition of inflammation for which they were used. This anatomic result may be a process of blockage of the reticulovascular system.

K. L. Stoll.

General

Rectal Narcosis in Ophthalmic Surgery. O. G. Morgan and J. M. Lees, Brit. J. Ophth. **14**: 577 (Nov.) 1930.

The authors consider that rectal narcosis with tribromethyl alcohol, within certain limits, wholly fulfils all the requirements demanded for its purpose. In minimal dosage, it allays fear and renders tolerable a certain amount of pain without the loss by the operator of the cooperation of the patient. In larger doses, it either suffices with a local anesthetic for operations hitherto requiring general anesthesia, or by reason of its narcotic effect reduces the amount of anesthesia required to a minimum. It is simple to give, requires no elaborate apparatus and only a little care in preparation.

It has no after-effects, the patient having universally constant, total amnesia for the operation in spite of some degree of apparent consciousness and waking later after a refreshing sleep. It reduces the degree of psychic shock to a minimum.

The authors state that the procedure followed throughout has been that suggested by Messrs. Bayer. Altogether more than fifty cases have been dealt with under this form of anesthesia, including extraction of cataract, acute glaucoma, excision, evisceration, acute dacrocystitis, removal of the lacrimal sac in chronic dacrocystitis and some cases of minor and major plastic operations on the eyelid. In conclusion, the

authors state that anesthesia with tribromethyl alcohol well merits a trial in ophthalmic surgery.

W. ZENTMAYER.

General Diseases

THE OCULAR COMPLICATIONS OF MALARIA. H. VILLARD, Arch. d'opht. **47:** 200 (April) 1930.

The author describes systematically the lesions of the eye which may complicate malaria. Although the diagnosis of the ocular condition may be made easily, the proof that it is of malarial origin is not so simple. The ocular conditions that may be seen in malarial patients are not always due to malaria, for these patients may also have other infections, such as syphilis.

S. B. MARLOW.

OPHTHALMOLOGIC EXPERIENCES IN THE CARE OF TUMORS OF THE BRAIN. E. VON HIPPEL, Arch. f. Augenh. **103:** 76 (June) 1930.

The author gives a résumé of his experience with 167 cases of choked disks due to various lesions of the brain, tumors, meningitis serosa, etc. Instead of lumbar punctures, he relies on the observations of the retinal venous pulse with the dynamometer as elaborated by Baurmann.

F. H. ADLER.

Lens

LENS MYOPIA CAUSED BY MICROPHAKIA. H. MEYER, Klin. Monatsbl. f. Augenh. **84:** 525 (April) 1930.

The condition of both eyes of a girl, aged 7, was practically the same; their external appearance was normal but for slight exophoria. Concave glasses of 12 diopters brought the vision of 6/50 up to 6/15 in the right eye and to 6/20 in the left. The pupils were centrally located, round and of normal function; the media were clear, and the fundi were without pathologic change; myopic conus was not present. Under mydriasis the edges of the lenses could be seen plainly, surrounded by a clear aphakic zone of about 0.5 to 1 mm. in width in which the fibers of the zonula appeared. The anterior chambers were shallow in the center and deeper at their periphery.

When examined by the slit-lamp the anterior, and still more, the posterior, surface of the lenses appeared abnormally arched. Subluxation or oscillation of the lenses was absent, indicating that the function of the fibers of the zonula was intact, although the shape of the lenses was approaching a spheroid form. The insertion of the fibers, however, was more restricted at the equator of the lenses than at the adjoining areas, thus limiting the physiologic change of their shape. The absence of a myopic conus, of a scleral sickle at the disk or of other myopic change in the fundus was indicative of uncomplicated lens myopia. The accommodation amounted to 2 diopters in each eye.

Hereditary abnormalities could not be found in the family of this patient. This rare congenital malformation comprised the entire lens system. The spheroid shape of the lenses was caused by the diminished

tension of the zonula which prevented the development of the breadth of the lenses. The development of microphakia or of ectopia of the lens depends on the resistance of the fibers of the zonula of the fetus. Ectopia will form when the fibers lack normal resistance in one direction, while microphakia will result if the fibers of the zonula all around the lens are weak and do not exert the tension necessary to stimulate normal development of the lens.

K. L. STOLL.

A CASE OF LUXATED LENS IN THE ANTERIOR CHAMBER. F. M. VELITCHEFF, Russ. Oft. J. **9**: 694 (May) 1930.

The author gives the history of a patient, aged 83, who had the right lens luxated into the anterior chamber, and who refused to be operated on. The author observed the patient for three years. At the end of this period, the lens was reduced to 3 mm. in size. It was brownish amber and situated at the angle of the anterior chamber, held in position by threads coming from the pupil (zonula). The pupil was round and reacted well to light, and the iris was tremulous. The vision of the right eye was 0.4 with a convex glass of 9 diopters. The eye was perfectly quiet at all times.

The interesting point of this case is that the presence of the lens in the anterior chamber for three years caused no irritation of the eye. There was a gradual "self-cure" of the cataract.

O. SITCHEVSKA.

Neurology

TUMOR OF THE POUCH OF RATHKE. F. TERRIEN and J. CHARAMIS, Arch. d'opht. **47**: 337 (June) 1930.

Because of the diversity of opinion on the subject and the rarity of these tumors, the authors take the occasion of a case report to review the facts available and to delimit the symptomatology of this class of cases. After presenting in detail the case of a woman, aged 36, they take up systematically the essential diagnostic features of tumors in this region. Tumors of the pouch of Rathke develop from fetal rests in the craniopharyngeal pouch and differ from the adenomas by certain characteristics which sometimes justify the suspicion of their presence. Having a congenital origin, they often develop early in young subjects. The authors refer to the report of Beckmann and Kubie, who in collecting twenty-one cases found that half occurred in patients over 20 years of age. Situated at the base of the brain, such tumors lead to internal hydrocephalus and early increased intracranial pressure. However, these symptoms, which make possible the differential diagnosis from adenoma, are infrequently met with in young patients. One characteristic feature of these tumors is the presence of plaques of calcification above an enlarged or normal sella turcica. They are present in the majority of cases and are pathognomonic. These calcified plaques may appear late, however, and may be absent at the first examination, hence the importance of repeated roentgen study. According to Jackson, 79 per cent of tumors of the hypophysis with an adiposogenital syndrome are craniopharyngeal pouch tumors. According to MacKenzie and Sosman, 80 per cent will show calcification. Symptoms, such as the endocrine dis-

turbances and enlargement of the sella, are equally present in intrasellar and suprasellar tumors. Visual symptoms are in themselves not helpful in the differential diagnosis, but simply direct the attention to the region of the hypophysis. An increase in the cell count of the spinal fluid has been found in several cases. The basal metabolism will sometimes be altered to a slight degree. The authors feel that the facts support the contention of Viggo Christiansen that, with the exception of the calcified plaques, there is no clinically diagnostic group of symptoms for suprasellar tumors.

S. B. MARLOW.

ON OPERATIONS FOR TUMORS OF THE BRAIN AND THEIR RESULTS. E. RANZI, Arch. f. Augenh. **103:** 92 (June) 1930.

The author relates experiences with various forms of decompression operations, and makes a plea for early operative intervention.

F. H. ADLER.

Ocular Muscles

PRISM GLASSES IN THE EARLY STAGES OF CONCOMITANT STRABISMUS. C. H. STATTLER, Klin. Monatsbl. f. Augenh. **84:** 813 (June) 1930.

Sensory correspondence of both retinae exists in beginning strabismus of children until ambylopia develops in one eye. This development may be prevented in some cases by the correction of the refractive error. The author prescribed prism combinations up to 20 degrees for both eyes in over 200 children in whom the vision was fairly or entirely equal in both eyes. Some of them were only 2 years old. Fusion was obtained in 57 of 135 children who wore their prisms for periods of time sufficiently long to allow reliable observations. Twelve children, too undeveloped to localize the double pictures, learned to do so later. Most favorable for restitution of binocular vision are those cases in which an existing strong amblyopia could be eliminated and those with an alternating strabismus present from the start. A high degree of amblyopia existed originally but could be overcome in 27 of the 57 cases. Combinations with 12 degrees prism for both eyes were the average in the cases which obtained binocular vision, and with 15 degrees in those which were lacking it. The strength of the prisms could be frequently reduced, in the course of the time, from 20 degrees for both eyes to 5, and from 10 to no prism. The shorter the duration of the strabismus, the better the results. The author's stereoscopic pictures are of great help. It is essential to regain binocular vision as soon as possible, either by prisms or by operations, for the permanent success depends on prompt binocular vision. Operations have been performed by the author in children of 2 years of age when the deviation was so high as to render binocular fixation by prisms impossible.

K. L. STOLL.

Operations

THE TECHNIC OF THE DIASCLERAL MAGNET OPERATION. W. COMBERG, Klin. Monatsbl. f. Augenh. **84:** 817 (June) 1930.

A solution of procaine hydrochloride with epinephrine is injected at the site of the contemplated incision and also retrobulbar, so as to

reduce the intraocular tension and to prevent prolapse of the vitreous. The patient, lying on his back, is told to look straight at the ceiling while the operator is looking perpendicularly down at the patient's eye. The meridian in which the splinter has been localized prior to the operation is marked with the tip of a Graefe knife, and a black suture is laid at that point through the conjunctiva and the outer layer of the sclera. This allows the globe to be rotated so that the operative field appears within the palpebral fissure. The suture is pulled in the direction of the meridian in which the splinter is lodged; in some cases it may be laid around the insertion of an external muscle of the eye. If the scleral incision must be made below the insertion of an external muscle, it may be partly resected. The conjunctiva is displaced, and a meridional, slightly curved incision is made. The tip of a hand magnet is introduced into the vitreous for a distance of 2 mm. A lesion of the uvea or retina will occur more readily if the tip is not introduced into the vitreous itself but just between the lips of the incision, because the splinter is drawn to the very tip at the magnet. The incision should be made back of the ora serrata if the splinter is lodged in the ciliary body. A graduated spatula, devised by the author, similar to those of Heine and of Terson, is used for the measurements. K. L. STOLL.

Orbit, Eyeball and Accessory Sinuses

TWO CASES OF GRANULOMA INVADING THE ORBIT DUE TO AN ASPERGILLUS. R. E. WRIGHT, Brit. J. Ophth. **14:** 601 (Nov.) 1930.

These cases were previously described in the *British Journal of Ophthalmology* (**11:** 545 [Nov.] 1927). At that time the cultures had not been worked out.

In the first case, the growth proved to be *Aspergillus oryzae*. The further history of the case is that the condition was at first much improved by roentgen treatment. The patient could not continue the treatment, and in 1929 the mass was larger than it was originally. Radium was then used without effect.

In the second case, the aspergillus was a species of a type of *Flavus*.

W. ZENTMAYER.

THE EXTIRPATION OF HYDATID CYSTS OF THE ORBIT BY SUBAPONEUROTIC ORBITOTOMY. J. ROLLET, Arch. d'opht. **47:** 296 (May) 1930.

The author reviews briefly the important features of this disease, and cites a case in which the patient was successfully treated by the author's method of subaponeurotic orbitotomy, which he first described in 1907. The technic is briefly summarized as follows: (1) suture of the lids, (2) external curvilinear incision of at least 3 cm. with the knife close to the bone, division of the aponeurons close to the orbital margin with a rugeur and (3) exploration of the orbit with a finger, without injury to the fascia, fat, muscles, vessels or nerves. In this way a hydatid cyst can be extirpated quite simply.

S. B. MARLOW.

The Pupil

THE ARGYLL ROBERTSON PHENOMENON. W. G. SPILLER, Arch. Neurol. & Psychiat. **24:** 566 (Sept.) 1930.

The author states that there are some who do not recognize a pupil as showing the Argyll Robertson phenomenon until the light reflex is completely abolished. He shows that this definition is not correct and makes a plea for better understanding of what is meant when one describes a patient as having an Argyll Robertson pupil.

He reports a case showing a unilateral Argyll Robertson pupil. The visual acuity was normal in each eye. The right pupil contracted normally to light, directly and consensually, and in convergence accommodation. The left pupil did not contract in the slightest degree in direct and consensual light reflex but did contract promptly in convergence. There were no synechia in either eye, and the fundi were normal. From this, he draws the conclusion that "the lesion was apparently in the center of pupillary innervation of the left eye in the oculomotor nucleus. The case is clinical proof that there must be a center in the oculomotor nucleus of each side that is concerned with the pupillary action on the same side."

The author does not give reasons why the lesion may not be considered in the intercalated fiber on the afferent pathway as described by Behr.

F. H. ADLER.

THE EMOTIONAL REACTION OF THE PUPIL. S. LIEBEN and R. H. KAHN, Arch. f. d. ges. Physiol. **225:** 699, 1930.

Experiments were undertaken to determine the dependence of the so-called sensory or emotional reaction of the pupil on the integrity of the cerebral cortex. Cats were used because of the advantages of change in form, as well as change in size, of the pupil on dilatation, and because of their marked susceptibility to emotional reactions.

1. The animals were anesthetized with an ether-chloroform mixture to the point of disappearance of the corneal reflex. This corresponds to the condition in man of complete loss of consciousness. During the increasing narcosis, there was a characteristic diminution in the emotional reaction of the animal. This could be divided into two characteristic phases, as described by Behr. In the first phase the dilatation is marked but occurs after considerable latency. This is followed by a much slower and less marked dilatation of the pupil, and between these phases there is usually a short pause during which the pupil is slightly constricted. During the recovery from deep narcosis, the second phase occurs alone, and only when the animal has recovered considerably is it possible to evoke the first phase of the response.

During these experiments, not only the relation of the emotional reaction of the pupil was observed but also other typical reflexes. Blood pressure and respiratory movements were recorded, the former from a cannula in a carotid artery and the latter by means of a Marey tambour. A femoral nerve was laid on electrodes and short tetanic stimuli given. A typical pressor reflex in the blood pressure took place, as well as characteristic changes in respiration, with the appearance of the second phase of the reaction of the pupil. The first phase of the pupillary

reaction occurred only when the animal was very lightly anesthetized, i. e., at the point of movements of the body muscles. It is apparent, therefore, that this phase of the reaction occurs only when the higher centers of the central nervous system are functioning.

2. A series of cats were decerebrated, and the pupillary reactions tested in a similar fashion. In these animals, other characteristic reflexes in the lids and external ocular muscles took place, but the pupils remained paralytic. Neither phase of the dilatation occurred. In decerebrating the animals, care was taken to prevent hemorrhage. Section of the sympathetic on both sides would not influence the reaction in the intact animal.

The authors believe, therefore, that the emotional dilatation of the pupil depends essentially on a diminution of the tonus of the sphincter muscle. They picture the reaction as being initiated in the cerebral cortex. At least the first phase apparently originates here, whereas the second phase may have a subcortical origin. They consider that this is most likely in the region of the thalamus.

F. H. ADLER.

Physiologic Optics

THE PHYSIOLOGIC AND CLINICAL VALUE OF THE CHROMATIC ABERRATIONS OF THE EYE. J. L. PECH, Arch. d'opht. **47:** 363 (June) 1930.

In the first part of this paper the author reviews the evidence as to whether or not the eye is achromatic, as Newton originally believed. The later work of Wallaston, Young, Fraunhofer and Helmholtz discredited this belief. Through the use of four strictly monochromatic kinds of light, the author determined that the normal eye is myopic for violet and blue, less myopic for green, practically emmetropic for yellow and hyperopic for red, and that no accommodative effort can render a normal eye emmetropic for blue or myopic for red.

Dejean, working with ametropes, concluded that a subject is only functionally myopic when he becomes myopic for red, and begins to be hyperopic or presbyopic when his punctum proximum for blue-green becomes too distant. The author then goes on to describe an instrument called an ericiscope designed by J. Peter. It consists of a box in which are two similar charts, one illuminated with monochromatic blue, the other with monochromatic red light. The use of this instrument is described and its sensitivity discussed. Photographs illustrate the principles involved.

The results of study of the chromatic aberrations of the eye seem to indicate that there is a great variation in the index of refraction of the media of the eye, which may be influenced by nutritional and other general conditions. He suggests that the different foci for the principal colors account in part for the uncertainity of the patient when the proper correcting glass is approached.

S. B. MARLOW.

THE LIGHT SENSE. G. OVIO and E. HERTEL. Ann. di ottal. e clin. ocul. **58:** 299 (April) 1930.

In this work, presented at the International Ophthalmological Congress, the authors review previous research on the light sense. The

differential sensitivity in bright illumination is supposed to be a function of the cones, that in low illumination, of the rods. The fraction representing the former has been estimated by various observers at from 1/64 to 1/100 in normal persons. Sensitivity in low illumination depends on dark adaptation and varies in various parts of the retina, being least in the macular region and greatest at the periphery. The various instruments devised for the examination of these functions are described and illustrated. The factors influencing the exactness of these instruments, of which the Förster photoptometer is the type, such as spatial sense, contrast, false light transmitted through the sclera and memory images of the object, are considered. The author does not believe that these factors interfere materially with the usefulness of the instruments for comparative tests. Another type of instrument for testing the light sense is based on various forms of black and white rotating disks. Such disks offer various shades of white through gray to black by which a differential sensitivity of from 1/120 to 1/360 may be made out. The best size of disk for such tests is one of 15 cm. with black rings 7 mm. thick, observed at 1 meter under constant illumination. Disks of complementary colors, as used by Hess and Engelking, serve to determine the differential chromatic sensitivity. A similar examination, for light sense only, may be made by arranging graduated gray threads in order between white and black. Ostwald's series made on the same principle comprises eight grades which the normal eye can perceive.

S. R. GIFFORD.

Physiology

THE DRAINAGE OF THE INTRA-OCULAR FLUIDS. W. S. DUKE-ELDER, Brit. J. Ophth. **14**: 620 (Dec.) 1930.

This is a critical consideration of the paper by Ridley (*Brit. J. Exper. Path.* **11**: 217, 1930) in which, according to the author, Ridley concludes that the greater part of the drainage of the aqueous humor occurs not through the canal of Schlemm but through the cornea into the conjunctival sac.

To Ridley's conclusion that "since minute particles such as those of india ink do not pass into the lumen of the canal from the anterior chamber (Nuel and Benoit, 1895), there is evidence that no such direct communication between the anterior chamber and the canal exists," the author replies that this can have no possible relation to the passage of the fluid, and since Ridley has failed to show that particular matter is delivered out of the eye through the cornea, this argument therefore denies his main thesis.

Against the experiments on which the theory of drainage through the cornea is based, he brings forward one which he considers conclusive. A needle connected to a reservoir is inserted into the anterior chamber of an anesthetized dog. The system is filled with methylene blue (methylthionine chloride, U. S. P.) and the pressure equilibrated by means of an air-bubble. The reservoir is raised giving a pressure head of from 1 to 2 mm. of mercury; colored fluid slowly flows into the anterior chamber; in one and a half minutes the episcleral veins are deeply dyed; there is no evidence of any coloration of the cornea nor

the minutest evidence of dye in the conjunctival sac. Admittedly, the circulation here is an artificially induced pressure circulation, but the available channels of exit are obviously via the canal of Schlemm and the episcleral veins and not by way of the cornea.

To the conclusion reached by Ridley that the conditions of experimentation employed by the author are unsatisfactory because in the chemical analysis pooled samples of aqueous humor and serum were employed, the reply is that this rough estimate of which it was stated "that it cannot lay claim to quantitative accuracy" was followed by a micro-analysis of the principal constituents of each class of substance of which accurate chemical estimation in quantities so minute is possible, and that these showed the same relationship. W. ZENTMAYER.

EXISTENCE OF AN OCULAR CENTER IN THE MIDBRAIN AND HINDBRAIN, KEN TAGA, Arch. f. d. ges. physiol. **223**: 116, 1929.

It has been questioned whether the fibers proceeding from the cortex to the oculomotor centers for conjugate deviation undergo interruption in the midbrain. These experiments were undertaken to decide this point.

Cats were used, and suitable electrical stimulation was applied to the cortex to produce conjugate deviation of the eyes. Sections were then made through various portions of the midbrain, and the persistence of the conjugate deviation noted. From these experiments, the author concludes that the tectum mesencephali is not essential for the existence of conjugate movements of the eye when the motor region is stimulated. The dorsal wall of the aqueductus sylvii, which contains the posterior commissure, can be destroyed without interfering with the effect. In the regions investigated, therefore, no evidence could be obtained that the fibers concerned with conjugate deviation undergo any interruption.

F. H. ADLER.

Refraction and Accommodation

AN INVESTIGATION INTO THE EFFECT UPON THE EYES OF OCCUPATIONS INVOLVING CLOSE WORK. W. S. DUKE-ELDER, Brit. J. Ophth. **14**: 609 (Dec.) 1930.

The investigations were undertaken in order to determine what effect, if any, continuous close work, such as is necessitated in many branches of industry, has on the eyes. It was thought probable that any deleterious effect would be most readily discovered in young adults in the second decade of life, since among those engaged in such work the eyes, being still to some extent in the period of growth and development, are in the most labile state. The study was made in the London School of Printing in which the majority of the pupils are between 14 and 20 years of age, and representative of the average physical standards. The hours of employment are on the average between 9 a. m. and 6 p. m.

The questions investigated were: visual acuity, the refractive error (if any), the power of accommodation, the state of the muscular balance, the presence and the degrees of binocular and stereoscopic vision. The

refraction was estimated by retinoscopy without the routine use of a cycloplegic. A difference of 0.5 diopter in estimations made in four successive examinations at intervals of nine months is recorded as an increase in myopia.

It would necessitate too long an abstract to give full statistical details. Eighty compositors were under observation. Of the emmetropes, 83.3 per cent remained stationary; 16.7 per cent became myopic; in these, the change was small. Of the myopes of small error, 18.2 per cent remained stationary and 81.8 per cent progressed by an average of —0.5 diopter. Of the myopes of large error, 33.3 per cent remained stationary; 66.6 per cent progressed by an average of —0.5 diopter; in 16.6 per cent the increase was rapid (from —0.75 to —1.50 diopters). Of hyperopes, 69 per cent remained stationary; 31 per cent became less hyperopic; in 12.5 per cent the decrease was rapid.

The conclusions drawn by the author are that it is obvious that the compositors do not bear comparison well with those engaged in other occupations. Not only does this group contain initially a considerably higher percentage of persons with myopia, but the number in which the refractive error increases toward the myopia is also higher. Moreover, the percentage suffering from a considerable amount of muscle imbalance is higher.

These figures suggest that the occupation which entails the greatest degree of eye strain has the most deleterious effect on the vision; and that one of the results of such an occupation is to encourage the development of short-sightedness. It is to be noted that some of the members of this class do complain of inadequacy of the illumination in the room, especially when working with artificial light.

It is to be remembered, of course, that the age period over which observations were taken represents a relatively labile phase in the refraction of the eye; and it is not to be expected that the same degree of progression will be evident in later life. W. ZENTMAYER.

TORIC SPECTACLES. A. S. PERCIVAL, Brit. J. Ophth. **14:** 623 (Dec.) 1930.

Toric lenses are based on +3, +6 and +9 diopters, the +6 base being the most common. A toric lens should be prescribed in the form of crossed cylinders or else the toric base should always be specified.

Rules are given for writing a spherocylinder as a toric lens combination. If, for instance, a +3 base is chosen for a + 2.50 + 1.50 axis 80 spherocylinder, then the prescription is written:

$$\frac{+3.0 \text{ diopters cylinder axis } 170 \text{ degrees} + 4.50 \text{ diopters cylinder axis } 80 \text{ degrees}}{-0.5 \text{ diopters}}$$

This means that the toric surface is to be placed anteriorly and the convex surface is to be placed next the eye.

A periscopic lens is designed to enable one to distinguish distinctly when looking obliquely through it. At the end of the article is a table giving what Percival considers the best curves and thicknesses of convex and concave lenses for far and for near use. It is our duty to order those toric lenses that will be of real service if we order them at all. There are six different ways in which the optician could grind a toric

lens of the foregoing power, but only one of them will give really satisfactory results with the tools in use, namely, that on a +9 diopter base. The best prescription for this spherocylinder that will give the greatest range of vision, when the eyes are rotated behind it, is:

+9.0 diopters cylinder axis 170 degrees +10.5 diopters cylinder axis 80 degrees
—6.5 diopters sphere

Other examples are given. For low powers of concave spherocylinders, toric lenses are unnecessary, provided that the concave spherical surface is placed next the eye. Certain lenses need only be transposed to render the ocular surfaces nearly those recommended in the table. For instance, —3.50 —3 axis 180, if transposed to —6.50 +3 axis 90, would be an almost perfect periscopic reading glass and would allow a very wide field for distance.

There is much more urgent call for periscopic glasses in the high convex than in the concave lenses. The thickness and the effective power of strong convex meniscus lenses are an important consideration.

For the induced astigmatism immediately after cataract extraction, it saves expense if a biconvex spherical lens is tilted the proper angle downward for temporary use. The permanent glasses are ordered after five or six months. Bifocal lenses are unsatisfactory for aphakic patients who require cylindric correction, as the reading wafer must be attached to the convex surface, which makes the meniscus lens of the wrong shape for reading.

Percival does not recommend bifocal lenses for myopic patients except in those cases in which the myopia is of very low degree. He states that in two years he has seen two patients with a myopia of less than 6 diopters who acquired a detached retina after wearing bifocal lenses.

A. COWAN.

Retina and Optic Nerve

ON THE MECHANISM OF DETACHMENT OF THE RETINA IN MYOPIA. K. W. MAJEWSKI, Arch. d'opht. **47:** 273 (May) 1930.

Many theories have been proposed to explain the pathogenesis of detachment of the retina in progressive myopia. Statistics indicate that spontaneous detachment is closely related to the state of the refraction and the pathologic lesions resulting from the progressive myopia. He points out that a detachment finally develops in at least 5 per cent of myopic eyes. Although von Graefe expressed the opinion many years ago that the elongation of the eye, due to a posterior sclerochoroiditis, was an important factor in the mechanism producing detachment, the two most recognized theories are those of Arlt and Leber-Nordenson. Arlt's theory supposes an inflammatory process in the choroid with the accumulation of a serous exudate between it and the retina. Leber's theory favors a primary lesion in the vitreous, with which the retina is more closely connected than the choroid. The fluid which collects beneath the retina has been satisfactorily proved by Jasinski to be in the nature of a transudate. The author points out the complete neglect by the many diverse theories for detachment of the retina, of the extensive anatomic changes causing the enlargement of the globe, which is inevitable in progressive myopia. He quotes part of a previous discussion: "We know that high myopia leads to a marked increase in

the size of the globe which can be supposed to be approximately spherical. The surface of a sphere as it enlarges increases proportionately to the square of the radius, and the volume according to the cube of the radius. Suppose, for example, the radius is doubled. The surface will then be increased four times and the volume eight times. It is clear then that the membranes forming the walls of the eye are under these conditions necessarily subjected to a very great distension, while the vitreous must imbibe water from neighbouring tissue in order to fill up such a tremendously increased space. Thus fluidity of the vitreous results. As for the membranes of the eye, the sclera, more elastic than the other, stretches without serious harm. The choroid in continuing to cover the greatly enlarged surface becomes very thin and sometimes undergoes extensive areolar atrophy. The retina on the other hand, being frail and delicate, can not be distended indefinitely. . . ."

The author then goes on to explain the changes which take place in the sclera, choroid, retina and vitreous. In general, it is only a retina which is stretched to the limit of its elasticity that becomes detached. A varying degree of elasticity explains why detachment occurs in some eyes and not in others. If there were no elasticity, the retina would either be detached in all cases, or else, remaining in place, be torn, broken off or disintegrated in some way. However, such lesions are never encountered in myopic eyes. It is only retinas already detached and undulating that frequently reveal holes and tears, and it is unimportant whether these tears are produced at the time of detachment or later. Confirmation of this explanation is found in the fact that one never sees detachment of the retina in cases of disseminated choroiditis in highly myopic eyes.

The tables and figures in support of the author's theory in the latter half of this paper do not lend themselves to condensation.

In conclusion the author repeats that his suggestions are hypothetic and need verification by direct measurement at some future time.

S. B. MARLOW.

Trachoma

THE SPREAD OF TRACHOMA AND THE CAMPAIGN AGAINST IT. EMILE DE GROSZ, Proc. Staff Meet., Mayo Clinic **5**: 303 (Oct.) 1930.

After pointing out the incidence of trachoma in various countries, the author, who is president of the International Organization for Combating Trachoma, states that he is a dualist, separating follicular conjunctivitis from real trachoma. He has no doubt as to the infectious character of the disease though he does not deny the importance of the patient's constitution, especially in relation to corneal complications.

He emphasizes the importance of reporting all cases. Defense should be instituted without delay on the basis of the data furnished. In Hungary ambulatory treatment is entrusted to the parish doctor after a suitable course of instruction. Where trachoma is present on a large scale, treatment is by experienced ophthalmologists. The eye hospitals for patients with trachoma are the most successful center of treatment, and it is the vocation of the hospitals to be intermediary stations in the

work of defense. The campaign is directed by the minister of welfare and public health. Persons of unsound mind suffering from trachoma should be relegated to separate trachoma departments of asylums. In districts largely contaminated with trachoma, special schools are provided for the afflicted children.

For instruction in the diagnosis and therapy of trachoma importance is attached to courses of instruction devoted to further education of the universities, and special courses of instruction on the subject of trachoma are advocated.

The defense against trachoma should be coordinated through international association. It is especially important that conventions should be held with neighboring states. Scientific research on the subject of trachoma should be promoted.

W. ZENTMAYER.

Tumors

ADENOCARCINOMA OF THE LACRIMAL GLAND. W. L. BENEDICT and A. C. BRODERS, Am. J. Ophth. **13**: 585 (July) 1930.

Adenocarcinomas, so-called mixed tumors, are usually situated in the upper outer part of the orbit. They are often referred to as tumors of the lacrimal glands, and presumably arise from cells of the lacrimal gland. The principal lobes of the gland are not involved. The accessory lacrimal glands (glands of Krause) probably give rise to epithelial tumors which may be classified as tumors of the lacrimal gland. Other glands of the orbit may give rise to tumors with more or less differentiation toward gland cells. The tumors may also contain myxomatous tissue, cartilage and sarcoma-like elements identical in structure with tumors of the parotid gland. These are designated mixed tumors. They cause exophthalmos and grow slowly; they are often single and encapsulated. If incompletely removed, they are prone to recur with increasing characteristics of malignancy. Five cases are reported, in four of which the tumors were encapsulated. The authors discuss the origin of these tumors and theories as to their genesis.

W. S. REESE.

CYLINDROMA OF THE ORBIT. M. DEL DUCA, Ann. di ottal. e clin. ocul. **58**: 319 (April) 1930.

Under the name cylindroma a number of tumors have been described, most having their origin in the lacrimal gland and consisting in a connective tissue stroma enclosing cords and tubules composed of epithelioid cells often containing hyaline material. The origin of these cells has been considered by various authors as epithelial, endothelial or mixed.

The case reported by the author is that of a man of 27 with a tumor at the upper outer border of the orbit of three years' duration. It had been operated on twice, with recurrence. The eye was pushed out and slightly down, but motility was normal. It was removed, with the lacrimal gland, to which it was adherent. Sections showed the tumor to be encapsulated with a stroma enclosing lobules of polyhedral cells with large nuclei. In and between these cells much hyaline material was to be seen, which was largest in amount at the centers of the lobules, forming typical cylinders. Vascular spaces were to be found

between the cells, and many showed proliferation of their lining endothelium. The lacrimal gland was normal, and a comparison of its structure with that of the tumor excluded the possibility that the latter might have originated from the gland itself. It was intimately connected with the gland capsule, however, and the author believes may have arisen from vessels of the capsule. He considers this tumor and the group of cylindromas in general to be of endothelial origin.

S. R. GIFFORD.

EXAMINATION OF THE CONTENTS OF AN ORBIT EXENTERATED FOR RETROBULBAR SARCOMA. M. DEL DUCA, Ann. di ottal. e clin. ocul. **58:** 329 (April) 1930.

The author's material was obtained from a girl of 5 with symptoms of retrobulbar tumor of seven or eight months' duration. On exposing the tumor, it was found to be intimately connected with the globe, so the orbit was eviscerated. Recurrence followed after six months. Sections showed a small round cell sarcoma apparently arising from the orbital connective tissue, and having involved the extra-ocular muscles and the sclera around its small vessels. Secondary inflammatory changes involved the periosteum, sclera and muscles. The interior of the eye, optic nerve and lacrimal gland were not involved.

S. R. GIFFORD.

THE HISTOGENESIS OF NAEVUS PIGMENTOSUS OF THE CONJUNCTIVA AND LIDS. N. Y. POCHISSOF, Russ. Oft. J. **9:** 779 (June) 1930.

The author reviews the main theories of the histogenesis of nevus. Unna expressed the belief that nevus cells develop from the basal layer of the epithelium. According to Ribbert, nevus cells are of mesenchymatous origin, being genetically identical with the chromatophores without reaching differentiation. Nevi consist of both nevus cells and chromatophores.

The author examined thirty-one cases of nevus microscopically. Twenty-two of these were nevi of the eye, and nine, nevi of the skin. In seven cases of nevi of the conjunctiva, the nevus cells were located in the subepithelial layer. The pigment was found only in the cells that closely resembled the chromatophores. The histopathology of nevi of the semilunar fold was that of a malignant new growth—a melanosarcoma. In the three cases in which the caruncle was involved the nevi resembled those of the conjunctiva. Here also the pigmentation was due to the chromatophores. In only three of eight cases of nevus of the skin was there proliferation of the epithelial cells, which were pigmented. In most of the cases, a layer of connective tissue was seen between the epithelium and the nevi cells. The nevi cells grew from inside toward the epithelium, at times replacing it altogether.

The author draws the following conclusions:

1. The nevi pigmentosa are of mesodermal origin; the final stage of development of the nevi cells are the chromatophores (Ribbert's theory).

2. In no case of nevi of the conjunctiva could any connection of nevi cells be observed with the epithelium. Nevi cells invade the epithelium, forming depressions and defects. The more developed the nevi cells are, the more atrophic are the epithelial layers.

3. Nevus pigmentosus in most cases is the result of the proliferation of the endothelium of the lymphatic vessels. Further growth and development of the nevi cells leads to their pigmentation and transformation into chromatophores.

4. Malignant tumors developing from nevi pigmentosa are melanosarcomas.

5. Since the histopathology of the nevi is not always characteristic of its nature, the clinical facts should aid in the diagnosis. Early removal of nevi is a prophylactic measure in combating malignant tumors.

O. SITCHEVSKA.

Uvea

CONGENITAL IRIDOCYCLITIS. H. MEYER, Klin. Monatsbl. f. Augenh. **85:** 55 (July) 1930.

Iritis in the new-born or that noticed during the first months of life is usually caused by syphilis, while tuberculous iritis appears in the second year of life. In the case here reported, that of an 8 weeks old infant, with congenital iridocyclitis, made apparent by changes in the pupils of both eyes, noticed directly after birth, syphilis of both the mother and the child was excluded by negative Wassermann reactions. The mother did not have tuberculosis and the baby gave a negative reaction to the Pirquet test.

Examination showed that the infant's corneas were clear; the pupils were rigid and covered by the gray film of an exudate which extended partly over the iris; the anterior chambers were deep; precipitates were noticeable on the iris and Descemet's membrane, and the aqueous humor was cloudy. When rabbits were inoculated by the method of Uhlenhuth with the child's aqueous humor, no spirochetes were found. Cataracts, probably due to erosion of the capsule of the lens by the pupillary exudate, were observed after dilatation of the pupils. Four weeks of daily treatment with inunctions of 0.5 Gm. of mercurial ointment were required to subdue the active inflammation. Symptoms of rickets developed during this period, and the tension of the right eye increased, requiring transfixation. A week later the tension in both eyes was 27 mm. of mercury. An optical iridectomy was performed in the left eye; this was followed by beginning secondary hydrophthalmos after three months; this was stopped and tension was normalized after an anterior sclerotomy. The child is developing well.

The course of this disease resembled that of tuberculous uveitis in adults. As tubercle bacilli cannot be excluded etiologically, they might, in the author's opinion, have been transmitted by the blood of the mother. Meyer rejects the possibility of transmission of toxin.

K. L. STOLL.

Society Transactions

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WILLIAM H. WILDER, M.D., *Chairman*

DISEASES OF THE PARANASAL SINUSES AND THEIR RELATIONS TO DISORDERS OF THE EYE. PROF. EMIL DE GROSZ, Budapest. Hungary.

About 100 cases of retrobulbar neuritis have been studied every year in the First University Eye Clinic at Budapest; 60 per cent of such cases have been due to the abuse of alcohol and tobacco, and 15 per cent to nasal disease. Sinusitis and multiple sclerosis must be considered in dealing with acute retrobulbar neuritis, while in the chronic type one must consider tobacco and alcohol, syphilis, diabetes, lead and Leber's hereditary atrophy.

Acute retrobulbar neuritis is often one of the first evidences of multiple sclerosis, which sometimes requires years to become full blown. The relationship between diseased sinuses and acute retrobulbar neuritis has been based on the sequence between sinus infection and the appearance of neuritis, on the anatomic proximity between the optic nerve and the nasal sinuses and on the observation that improvement in the sinus is sometimes attended by improvement in the function of the nerve. Optic neuritis may be produced in several ways, e. g., by the action of toxins on the papillomacular bundle and by the circulatory embarrassment of the bundle from pressure caused by perineuritis. In all cases of acute retrobulbar neuritis, therefore, a simultaneous ophthalmologic, rhinologic, neurologic and roentgen examination should be made, as well as a most careful record of visual acuity with correction, of the central and peripheral visual fields, of the appearance of the nerve head and of the nasal and neurologic condition. If conservative treatment fails to produce improvement in the ocular condition within a reasonable time, the sinuses should be explored, even in the presence of negative nasal and roentgen observations.

DISCUSSION

DR. JAMES A. BABBITT, Philadelphia: (The subject was discussed from the standpoint of the rhinologist. An extensive literature was reviewed, dealing with the proximity of the sinus walls to the optic nerve, with dehiscence and necrosis of the sinus walls, with hyperplasias and disturbances in the function of the optic nerve due to pressure, with transmission of toxins through the blood and lymph, with septic thrombophlebitis and with allergy.)

In the presence of acute retrobulbar neuritis, a thorough nasal study is indicated, using full shrinkage of the tissues and a nasopharyngoscope, studying the discharges and bacterial content, utilizing transillumination

and irradiation. Prompt surgical measures are required whenever infection is found, and whenever adequate cause for the disturbed ocular function cannot be found elsewhere. Patients with retrobulbar neuritis may have multiple sclerosis or tumor of the brain, and coincidentally nasal disease.

Dr. Sanford R. Gifford, Chicago: (The subject was discussed from the point of view of the ophthalmologist, under the following three headings: the frequency of retrobulbar neuritis due to sinus disease, the pathologic process of sinusitis causing retrobulbar neuritis, and in these cases the question of operating on sinuses in the presence of negative nasal and roentgen observations.)

In cases in which reduced vision is due to intracranial disease or in which valuable time has been lost through useless nasal operations, the neurosurgeon believes that nasal causes for optic neuritis are of minimum importance. The eye, ear, nose and throat specialist, often without sufficiently frequent consultation with the neurologist, mistakes the transitory retrobulbar neuritis of multiple sclerosis for one which appears to be benefited by an intranasal operation. White is an illuminating example of honesty in rhinologic opinion; his first seventeen cases of retrobulbar neuritis were all considered as due to sinusitis, while later experience led him to consider the sinuses as only one of the actual causes, and a relatively unimportant one. When the ophthalmologist, neurologist and rhinologist together attack the problem of acute retrobulbar neuritis, they find in the majority of cases that the cause is elsewhere than in the nose. Multiple sclerosis accounts for about 50 per cent of all cases, and ingested toxins and intracranial disease increase this figure to about 80 per cent. Purulent sinusitis accounts for about 3 per cent of all cases. The remaining cases, that is, from 15 to 20 per cent, present no evidence of local or general disease discoverable by present day methods. There is evidence that acute nasal infections may contribute to this indeterminate group, (1) through closure of the sinus ostia by hyperemia of the mucosa producing within the sinus a negative pressure, which facilitates the taking up of toxins and bacteria by the blood, or (2) through direct extension producing edema of the nerve sheaths. All tissues removed from the nose in these cases should be subjected to thorough histologic study. All cases of retrobulbar neuritis should be considered as emergencies, and studied at the earliest possible moment by ophthalmologist, neurologist and rhinologist. Intracranial disease should always be looked for. While it is difficult to establish a diagnosis of multiple sclerosis in the early stages, a lost abdominal reflex or any other sign of this disease will indicate the diagnosis. For the cases of nasal origin, in which disease can be demonstrated, surgical measures are in order. When a nasal origin is suspected, but not proved, the patient should be treated conservatively for several weeks by means of sweats and epinephrine packs in the nose, with a nasal operation as a last resort.

Operations on the Muscles, with Special Reference to the Tucking Method. Dr. F. E. Burch and Dr. H. W. Grant, St. Paul.

The adequate correction of refractive errors, and the application of educational measures to reduce amblyopia and to increase fusion will

result in success in 50 per cent of all cases of functional strabismus and of heterophoria. Deliberate surgical measures are indicated for the remainder.

The tucking operation was employed 197 times in 144 patients during the past ten years. (The technic of the operation was described and illustrated by slides and by cinema; it is set forth in detail in the author's article in the pre-session volume.) In estimating the amount of necessary shortening of the muscle, one must take into account the remedial effect of the full correction in glasses, the duration of the squint and the presence of contractures and basic vertical imbalance. Thus each patient offers a separate problem. In general, when the opponent muscle is uncut, each millimeter of shortening will yield 2.5 degrees of correction, possibly more (3 degrees) in the vertical meridian and less (2 degrees) in the lateral meridian. An attenuated muscle requires a more generous tuck than does a sturdy muscle. When the opponent is uncut, the maximum correction obtainable in one eye by tucking the inferior rectus is 12 degrees; by tucking the internal rectus, 12 degrees, and by tucking the external rectus, 16 degrees. If it is desirable to correct higher deviations, the employment of the Curdy-Wilkinson recession technic will yield about 4 degrees of correction for each millimeter of recession, although there is considerable latitude of variation in this figure. The maximum correction obtainable by combining tucking with recession is about 35 degrees, operating on one eye alone. In alternating strabismus, tucking should always be done equally on both eyes. Thirty degrees of correction can be obtained from tucking both externi, and this amount can be increased by recession either at the first operation or later. Tucking is desirable on account of its safety, ease of performance and preservation of the original attachment to the globe. The tuck is secured by silk sutures, left buried, and the conjunctiva is closed by a running silk suture, which is easily withdrawn without discomfort on the fifth day.

DISCUSSION

DR. W. B. LANCASTER, Boston: The simple resection is superior to the tucking operation, in that a more accurate measurement may be obtained. In general, rules and measurements are helpful, but experience must be relied on for the final decision. Each case is a special problem.

DR. LUTHER C. PETER, Philadelphia: Tucking has definite indications. Exception may be taken to the central suture used by Dr. Burch and Dr. Grant, as necrosis may follow. Chronic catgut is probably better suture material than silk in these cases. Tucking is especially good for relief of the phorias. Recession is probably better than partial tenotomy.

DR. S. B. MUNCASTER, Washington, D. C.: The tucking operation is indicated, except when the muscles are inserted so far back on the eyeball that a tuck cannot be made. It is also desirable in the case of atrophic muscles.

DR. RODERIC O'CONNOR, San Francisco: I should like to call attention to the importance of habit contractions and relaxations of the ocular muscles, as explained by Sherrington's law of reciprocal innervation. Shortening of a muscle does not abolish its habit impulse to relax, which

permits the eye to return more or less to its original position. My method of operation is to be recommended, as scleral sutures are always risky, especially in the thin sclera of a young child. Glasses will straighten the eyes at once if they are going to at all.

DR. WILLIAM THORNWALL DAVIS, Washington, D. C.: It is desirable to correct the patient's squint before school age. The use of full hypermetropic correction during the developmental period often makes it necessary for the patient always to wear glasses; thus the advisability of early operation and early cure without glasses is shown.

DR. BURCH: The amount of correction obtained by tucking a single muscle is rarely over 25 degrees. The tucking method offers an opportunity for safer operations at an earlier age than any other procedure.

TAY-SACHS-SCHAEFFER DISEASE: I. REVIEW OF THE DISEASE AND ALLIED CONDITIONS. DR. JOSEPH I. GOUTERMAN, Philadelphia.

These allied conditions are too prevalent for one to keep track of all cases reported in the literature. The allied conditions may be grouped under three general headings:

1. The infantile type. This is limited to the Jewish race; the onset is from the third to the sixth month in a previously healthy infant. It is characterized by a cherry-red spot at the macula, progressive loss of sight bilaterally, loss of muscular power, dementia and death by the end of the second year.

2. The juvenile type. This is not race selective. It has its onset from the fifth to the seventh year, with a more retarded course than the infantile type, and death by the twelfth year. The child slowly becomes demented, blind and spastic, in that order, and the ocular fundi show pigmented maculae instead of cherry-red spots.

3. The adolescent type. This is not race selective; its onset is from the fourteenth to the sixteenth year. There is no dementia. Central scotoma (bilateral) with pigmented maculae, and finally loss of muscular power are observed. The condition is not fatal.

TAY-SACHS-SCHAEFFER DISEASE: II. HISTOPATHOLOGY. DR. N. W. WINKLEMAN, Philadelphia.

Tay first described the ocular symptoms of this syndrome; Sachs the clinical and neurologic picture, and Schaeffer the pathognomonic ganglion cell changes present in the entire central nervous system, with the disappearance of Nissl granules, accumulation of lipoidal substance in the cells and swelling of the neurofibrils.

DISCUSSION ON PAPERS OF DR. GOUTERMAN AND DR. WINKLEMAN

DR. LUTHER C. PETER, Philadelphia: From a more or less confused accumulation of observations as to the symptomatology of Tay-Sachs' disease, order has been brought out of chaos by classification into three groups, namely, the infantile, the juvenile and the adolescent types. The first occurs in apparently normal infants of Jewish parentage, is marked by paralysis, idiocy, optic atrophy and a cherry-red spot in the macula surrounded by a pale zone, and terminates fatally, as a rule, before the end of the second year. The diagnosis in this group offers little difficulty.

The second or juvenile type is not race selective. It begins in apparently healthy children from 6 to 8 years of age, with mental deterioration, visual loss associated with atrophy and macular degeneration, and finally motor disturbance. The disease terminates fatally, as a rule, before the twelfth year. The cherry-red spot is not in evidence, but is replaced by varying degrees of macular pigmentation.

The third or adolescent type has its onset between the fourteenth and twentieth years. It is not race selective. Visual disturbance and motor weakness are the same as in the other types, but mental deterioration is not found. It may not be fatal. This group is in need of further study to place its diagnosis in the clearcut category of the infantile and juvenile varieties. The one definite phase of the adolescent group is shared with the other types, namely, the pathologic process.

Dr. Parker Heath, Detroit: Pick and Bielschowsky recently noted an association between Niemann-Pick's disease, which is a familial lipoid disease of the infant, and Tay-Sachs' amaurotic family idiocy. Rowland recently correlated the pathologic and clinical observations in Niemann-Pick's disease, Gaucher's disease and the Schiller-Christian syndrome—all manifestations of lipoid histiocytosis. At the recent meeting of the American Medical Association I suggested that a number of little understood lesions of the fundus which exhibited familial and constitutional tendencies be grouped under the single head of basic lipoid disease.

There have been many studies of the pathologic process of Tay-Sachs' disease, including those of Hassin and Schaeffer, largely confined to the nerve tissue. These studies are practically in agreement, but Schaeffer feels that the Tay-Sachs syndrome is purely ectodermal and is not concerned with the mesodermal reticulum. However, lipoids are found extensively in many of the cellular changes, both early and late. It seems fairly well accepted that the pathologic changes present in this syndrome, as described in juvenile, infant and adult forms, are practically identical. It is a familial disease characterized by peculiar lipoid degenerations of the ganglion cells, apparently constitutional, and in the infantile form racial.

In searching for the etiology we are handicapped because studies of the living are incomplete. Studies after death have been made largely on nerve tissues. Further work should be directed along lines showing the chemistry of the blood stream, and complete necropsy studies should be made. It is likely that an excess of lipoid will be found elsewhere than in ganglion cells in this tissue. I would therefore urge that repeated chemical studies of the blood be made in Tay-Sachs' disease, and, in the event of the death of the patient, that the postmortem material be examined thoroughly.

Dr. Isadore Goldstein, New York: My remarks refer to Niemann-Pick's disease, which Dr. Wexler and myself recently studied.

Niemann-Pick's disease is a familial disease of a certain type. The abdomen is distended owing to an enlarged liver and spleen. The skin is light brown. The blood smear presents a large number of vacuolated lymphocytes. The cherry-red spot at the macula is similar to that seen in Tay-Sachs' disease (amaurotic family idiocy). The changes in the disk, however, differ in Niemann-Pick's disease. They are yellowish,

owing to deposits of lipoid in the nerve, while in amaurotic family idiocy they are usually atrophic. The pathologic process is that of a general histiocytosis. There is a disturbance of lipoid metabolism. Most cells have lipoid in them, the excess of lipoid being taken up by the histiocytes which appear as foam cells. Few of these foam cells are seen in the retina. The changes in the ganglion cells are the same as in amaurotic family idiocy, except that they are more severe. Through the choroid foam cells are encountered frequently, some of them containing pigment. Throughout the sclera many foam cells are seen. The ganglion cells accompanying the ciliary nerves show the same changes as those occurring in the brain.

DR. GOUTERMAN: According to Bielschowsky, the pathogenesis of amaurotic family idiocy must be linked with the source of lipoid substance formed within the cells. This phase was elaborately worked out by Bloom, Niemann and others.

In 1914, Pick reported seven cases of the Niemann-Pick type in which he made a complete examination of all the organs, including the central nervous system; he also recorded that in one of these cases, easily recognized as a form of the Niemann-Pick type, all the cardinal symptoms of the Tay-Sachs variety were present. It was Pick's contention that in Gaucher's, Niemann-Pick's and Tay-Sachs' disease the same disturbance in lipoid metabolism is the predominant factor. When this metabolic disturbance affects the entire body, Gaucher's or Niemann-Pick's type is developed. The former might be called the juvenile, and the latter the infantile form of splenohepatomegaly or lipoid histiocytosis. The Tay-Sachs form is a disturbance of the same kind restricted to the nervous system.

ESTIMATION OF THE TOTAL REFRACTIVE ERROR WITHOUT THE AID OF CYCLOPLEGIA. DR. DORLAND SMITH, Bridgeport, Conn.

A method of refraction, under what is termed "cyclodamia" (well controlled accommodation), requires no cycloplegia but rather the application of novel methods, in order to place accommodative tendency at a minimum. This is done by skiascopy with the patient binocularly fixing a distant point; the cylindric correction is verified by keratometry, and then with this combined information one incorporates with the indicated cylindric lens sufficient plus sphere to prevent the patient from reading better than 6/60 binocularly. After sufficient time has elapsed for the maximum relaxation of the accommodation, the strength of the lens is rechecked and the strength recorded. Deduction of 1.5 diopters should give the true refractive correction in the favorable cases. The test is repeated, the sphere being reduced until both eyes can read 6/12. A deduction of 0.5 diopter from this amount should check with the first test. Finally, the spheres are weakened until the maximum acuity is obtained, at which time the astigmatic correction is verified subjectively. This method is more reliable than "fogging" or homatropine cycloplegia, but is less dependable than atropine cycloplegia.

DISCUSSION

DR. S. J. BEACH, Portland, Me.: As a more reliable substitute for cycloplegia than fogging and the like, cyclodamia has an obvious field.

This is in cases in which the atropine group is contraindicated, and in the larger group in which its use is inexpedient; e.g., the recent case of a college student seized with acute eyestrain in the midst of examinations, or that of a banker arranging the details of a merger.

What I really wish to insist on is the value of this method as a check on cycloplegic refraction. One is too prone to forget that the reliability of atropine is only moderate; further, the relaxation from homatropine resembles complete cycloplegia only as mist resembles rain. When it is desirable to know the total error of refraction—and this should include most of one's work—I find Dr. Smith's method more trustworthy than much that passes for cycloplegia.

Dr. Edward Jackson, Denver: In irregular astigmatism, retinoscopic observations with the dilated pupil are not reliable. With a plus 1 sphere added to blur vision, one can detect a 5 degree change in the axis and a .25 change in the strength of the cylinder if cross cylinders are employed.

Dr. W. B. Lancaster, Boston: (The Tscherning schematic eye and the variations in refraction in different areas of the enlarged pupil were presented.) Better results are obtained, as a rule, without cycloplegia.

Dr. William Crisp, Denver: In three out of four patients, the precycloplegic estimate comes close to the cycloplegic determination. When cycloplegia is used, only the central area should be refracted.

Sporothrix Infection of the Eye and Adnexa. Dr. Howard F. Hill, Waterville, Me.

The literature on ocular sporotrichosis was reviewed. A patient with *Sporothrix* infection of the orbit was treated actively with potassium iodide for five years, without benefit; finally radical surgical exenteration was performed on account of invasion of the bony orbit and sinuses. The process started as a small recurrent nodule on the upper lid, which had been curetted as a chalazion by another physician. The mass was excised; on section it was found to be made up of giant cell inflammatory tissue. A fistula appeared after operation, and *Sporothrix* was isolated from the discharge by culture. There was a constant eosinophilia of 7 per cent. In spite of the use of potassium iodide to the point of tolerance, the growth extended and involved the malar and frontal bones; enlargement of the lymph nodes appeared in the neck and the inguinal region. Irradiation was of no avail. The eye became proptosed, and a hypopyon ulcer developed. A radical operation was employed to empty the orbit of all diseased tissue, and the outer walls of the orbit and the antrum were removed. Three months later, a small nodule had to be removed from the canine fossa. During the subsequent five months there were no recurrences around the face.

Dr. A. J. Bedell, Albany, N. Y.: Dr. Hill's case differs from most cases of sporotrichosis in its severity, and its resistance to iodides. A case that I observed presented a mass resembling granulation tissue on the tarsal conjunctiva, and a discharge from both canaliculi. On slitting the canaliculi, five brown concretions were removed; from these, Sporothrix was recovered in culture. The lesion cleared up under potassium iodide therapy.

ROSETTE FORMATION IN THE EYES OF IRRADIATED HUMAN EMBRYOS. DR. I. GOLDSTEIN and DR. D. WEXLER, New York.

This article will appear in full in a later issue of the ARCHIVES.

DISCUSSION

DR. E. V. L. BROWN, Chicago: I have little to add to this excellent presentation of the subject.

Dr. Goldstein and Dr. Wexler have undoubtedly demonstrated the formation of rosettes at a much earlier stage than has ever before been seen in microphthalmic or gliomatous eyes. E. Fuchs said that these rosettes are the result of overstimulation of the retinal layers. The authors spoke of the inhibition of closure by the mesoderm, regarded for decades as the genesis of the condition. In this connection I wish to call attention to the recent lectures of Dr. Ida Mann in this country, and to present a chart explaining a more recent view, namely, that the condition is due to overstimulation, which would be in exact keeping with the author's observations.

The first drawing shows retinal layers in normal closure. According to the author's view, closure would be prevented by persistence of the mesoderm at this point. Dr. Mann did not find this to be the case; instead the overgrowth of the retina downward meets and blocks the ends of the pigment epithelial layers. Thus the overgrowth of the inner layers of the retina occludes the pigment epithelium at a point farther back from the center of the cleft than the layers of the nuclear portion of the retina proper.

DR. WILLIAM C. FINNOFF, Denver: There is one point in which I differ from Dr. Goldstein and Dr. Wexler, and that is the statement made regarding rosettes in glioma or retinoblastoma as compared with the rosettes shown at this meeting. I think that the rosettes shown are identical with the rosettes seen in retinoblastoma. The true rosettes in retinoblastoma represent the outer ectodermal layers, the layers of rods and cones with the external limiting membrane, and the statement that in retinoblastoma, or so-called glioma, a blood vessel is found in the center of the rosette is inaccurate. The center of the rosette in retinoblastoma is exactly the same as that in the rosettes just shown, i. e., a group of protoplasmic processes radiating from an avascular center with the nuclei toward the periphery. There is an erroneous impression, held I think by many pathologists, that the central blood vessel surrounded by cells is a part of the rosette formation. These rosettes were first observed in so-called glioma by Flexner and not by Wintersteiner as is commonly believed.

It will be interesting to irradiate embryos at the time of the earliest stage of differentiation of the ectodermal layers into the retina to determine whether rosettes form from the outer layers of the retina just at the time that they appear. The differentiation of the rods and cones occurs late; it takes place first in the posterior portion of the globe and then progresses forward. This late formation of the layer of rods and cones in the embryo might explain the absence of rosettes in the region of the ora serrata, and the frequent formation of these structures in the posterior portion of the globe in the specimen shown.

I think that this has been a valuable work and probably will throw some light on the etiology or the method of development of these malignant tumors of the retina.

CALCIUM IN RELATION TO CATARACT. DR. DANIEL B. KIRBY, New York.

This article will appear in full in a later issue of the ARCHIVES.

DISCUSSION

DR. A. D. RUEDEMANN, Cleveland: I wish to mention our series of 136 cases of postoperative tetany in which there were 8 instances of postoperative cataract. These tetany cataracts have a definite appearance in that there is granular distribution beneath the posterior capsule. In all cases the patients were women; two were over 50 years of age, one 40, and the rest between 30 and 40. The first symptom complained of was diminution of vision which lasted from fifteen minutes to three or four hours; during this period they had a marked blurring, when they were unable to make out any object, and some complained of almost complete blindness. I feel that this is a severe ciliary spasm, because putting the patients in a dark room and covering their eyes produced relaxation quicker than anything else did. The tetanic type of cataract developed rapidly in 4 cases, and all went on to complete cataract in one month. They were all successfully operated on; in 6, the cataract was removed surgically, with good results in 5, and with prolapse of the iris postoperatively in 1. In these cases the calcium values must be controlled or the healing will be much prolonged. All cases had a very low calcium metabolism, the content ranging from 5.5 to 8.7 mg., and there was a very low phosphorus content, a condition that may play some part in the tetanic convulsions in these cases. All the cases of tetany are controlled by the administration of calcium or parathyroid extract or both, in conjunction with some other substance added to the diet, because some patients do not absorb calcium lactate under ordinary conditions.

I believe that Dr. Kirby is on the right track: that many of these cases of senile cataract can be missed; that many of them go through a period of senescence, when there is definite disturbance of the endocrine system or disturbance of the metabolism of the body, for it is certainly disturbance of the metabolism one way or the other that brings on this type of cataract.

DR. FREDERICK A. DAVIS, Madison, Wis.: I observed a married woman, aged 33, who had bilateral cataract following a thyroidectomy, in whom the blood calcium was reduced to 4.9 mg. per hundred cubic centimeters. A diagnosis of tetany from parathyroid deficiency was made by the medical department. The lenses were diffusely cloudy, giving the appearance of a homogeneous involvement of the entire cortex.

I do not think that one can definitely draw the conclusion that the lowered blood calcium per se is responsible for the clouding of the lens, as Dr. Kirby showed that there is no deficiency in blood calcium in patients with senile cataract. The repeated trauma to the lens which possibly accompanies the violent muscular contractions of tetany may be the etiologic factor, as suggested by Roemer.

DR. C. S. O'BRIEN, Iowa City: I shall say a few words on the relation of calcium to cataract. A number of observations on normal lenses have been published. Burgin and Schlonika found a trace of calcium in ox lenses, and Burgin found 0.08 per cent in pig lenses, but none in the human eye. Dr. Salit found no calcium in normal ox and rabbit lenses. Adams found 18.5 mg. in normal lenses. Dr. Salit examined forty-five cataractous lenses and found 35.4 mg. of calcium per hundred cubic centimeters, ranging from 2.8 to 100 per cent. He found no calcium in five cases of incipient cataract, and no calcium in one case of black cataract. This appeals to me as having some importance. Dr. Salit found 7.2 mg. per hundred cubic centimeters in the vitreous of ox eyes. The human vitreous, I think, has not been examined, or at least reports have not been published.

We found in Iowa that there was a decrease in the hydrogen ion concentration. In senility the vitreous became more alkaline as the individual aged. It has also been found (in Dr. Brown's department at the Cook County Hospital, Chicago) that the carbon dioxide content of the blood also decreases with age. It may be that the theory of calcium formation or deposition in the lens in senile cataract is more or less the same as A. G. Parsons' theory of the deposition of calcium in the bone: that the diffusible calcium of the blood exists as ions of dicalcium phosphate or calcium bicarbonate. When these ions arrive in bone where the carbon dioxide content is lower than that of the blood, calcium is precipitated as tricalcium phosphate.

It is my belief that calcium occurs as a result and not as a cause of cataract.

LATTICE KERATITIS: FIVE CASES IN ONE FAMILY. DR. ALLEN GREENWOOD, Boston.

A familial, bilateral, progressive, noninflammatory dystrophy of the cornea, not benefited by any treatment, was exemplified by five cases. The term "lattice keratitis" is preferred because it is most descriptive of the appearance. The right eye was always the first to become affected in the cases reported, a group that included a mother, two daughters, a son and a grandchild, all overweight. The condition is the same as that reported by Gallemaerts under the term "keratite grillagée," and by others as nodular or grill-like keratitis. The affected cornea is devoid of blood vessels, and the degeneration begins in the stroma of the central cornea after the third decade. The slit-lamp picture presents a clear peripheral corneal band, several millimeters wide and adjacent to the limbus, and a thickened, roughened and cloudy cornea elsewhere. The opacities consist of two types: (1) a syncytial net of refractile cords of unequal caliber, densely matted centrally and terminating in pointed tips peripherally near the limbus; these cords are situated in the stroma at various depths, and appear later to involve Bowman's and Descemet's membranes; (2) flocculent clusters with ill defined edges, situated in the central cornea at all depths, and occasional cystic spaces containing fluid. In one case thyroid extract was tried without success. No tissue was available for histologic study, but similar studies by Paderstein, Wirth and Goar were cited as disclosing a hyaline content in the corneal stroma.

DISCUSSION

DR. RICHARD GAMBLE, Chicago: Epithelial changes are seen in the older cases of this type, and may be considered as secondary to the changes in the deeper layers, which perhaps are of the nature of abiotrophy. These changes may be degeneration of the stroma, nerve fibers or fixed corneal corpuscles.

MODIFIED BARRAQUER CATARACT OPERATION. DR. OTIS R. WOLFE, Marshalltown, Iowa.

The Barraquer and Green technics were modified as follows: A preliminary iridectomy is performed ten days before extraction of the lens. A large corneal section is made and the suture is placed. The upper portion of the cornea is turned down, so that the eresiphake may be applied by direct view. The lens is rocked, and counterpressure is applied at the lower limbus, causing delivery of the lens without tumbling. Tumbling may be employed by setting the eresiphake lower on the lens capsule. The suture is then pulled tight, and the eye closed for fifteen minutes to prevent the loss of vitreous. After this lapse of time, the conjunctival flap is smoothed out. In the past seven years, 260 patients were operated on, with increasingly good results. Loss of vitreous was reduced from 22 per cent in the first group to 12 per cent in the recent group, and lenses in unbroken capsules were secured in 72 per cent of the first group as compared with 85 per cent of the recent group. (The various complications were discussed.)

DISCUSSION

DR. H. W. WOODRUFF, Joliet, Ill.: Only in selected cases should the intracapsular method be used. The cataract incision should vary according to the age of the patient. The Van Lint sliding flap is to be recommended. For the ophthalmologist who has only a small number of these cases each year, capsulotomy is the best. If the operator's experience is larger, one of the intracapsular methods should be mastered to use in suitable cases.

DR. W. B. LANCASTER, Boston: Operators should first perfect themselves in capsulotomy until loss of vitreous and complications in the iris occur in decidedly less than 10 per cent of cases. The intracapsular operation may then be tried. In using the forceps to dislocate the lens, pressure should be applied before one grasps the lens. Then dislocation will be successful in a much larger percentage of cases. This method is better and safer than the vacuum cup method.

DR. S. G. HIGGINS, Milwaukee: The use of a modified Kalt suture is desirable.

DR. A. S. GREEN, San Francisco: I desire to give a few notes of warning to prevent unwarranted condemnation of the intracapsular operation and probably the loss of many eyes.

Early in our work with cataract we, like Dr. Wolfe and others, thought that the intracapsular operation was suitable for practically all forms of senile cataract. Before long, however, and at the expense, perhaps, of some avoidable losses, we began to realize that we were over-enthusiastic. We select our cases more carefully now than in the beginning. In the past twelve years or more, our intracapsular opera-

tions have been consistently about 65 per cent, with the consequence that our general results have been much better. For the intracapsular operation we rule out practically all persons under the age of 55, and some under the age of 60. But there is no upper age limit; the older the patient, the more suitable he is for the intracapsular operation. In old iritis or iridocyclitis and diabetes we prefer to use the intracapsular procedure to avoid precipitating inflammation afterward. We rule out persons with myopia, prominent eyes and glaucoma. The final decision as to whether we will perform an intracapsular or a capsulotomy operation is reached only after the section is made. If, after the section, there is the slightest gaping of the wound, or if horizontal streaks appear on the cornea from the point of entrance to the point of exit, under no circumstances must an intracapsular operation be undertaken.

Since adhering to these positive indications and contraindications we have had loss of vitreous in less than 3 per cent of cases, and ruptured capsules in less than 2 per cent.

Dr. W. A. Fisher, Chicago: I prefer not to decide which intracapsular method to use until after the incision has been made. If blood in the anterior chamber obstructs the field of operation and cannot be removed, or if the pupil is too small, the Smith method is selected, but with many modifications. The testimony from all over the world seems to be in favor of some form of intracapsular operation. Many operators believe that the time is near when some form of intracapsular operation will be generally adopted, owing, in part, to better methods of anesthesia.

Dr. O. B. Nugent, Chicago: In my hands the Barraquer operation is the ideal method, in that it combines in one system the best attributes of all methods thus far devised. With this method no more capsules should be burst than with the Smith operation, and much less than with the forceps method. The percentage of loss of vitreous should be the same as that with the forceps method.

Our method further differs from that described by Dr. Wolfe in that we prefer to make a small peripheral iridectomy after the lens is delivered. This is one of the most difficult steps in the operation, and we have been able to simplify it by using a small iridectomy hook which facilitates the picking up of the iris with greater ease than when the iris forceps is used.

Dr. Wolfe: One thing that I consider particularly important in this operation is that the stitch is not only looped but tied; my associate draws the sutures tight, and if the vitreous bulges we immediately close the eye and wait ten minutes. That is probably the most valuable thing in the whole procedure to prevent loss of vitreous. It is surprising how the vitreous will settle back after ten minutes, and its loss will be completely obviated. Our limited experience indicates that while loss of vitreous is highly undesirable, even in small amounts, it is less to be feared than the complications resulting from retained capsule and lens débris.

Herpes and Allied Conditions. Dr. Ralph I. Lloyd, Brooklyn.

Jonathan Hutchinson contended that the eye is more likely to become involved when vesicles appear along the course of the nasal branch of

the first division of the trigeminus. Wyss found small hemorrhages and round cell infiltration of the gasserian ganglion in herpes zoster. Zoster vesicles on the cornea do not contain virus which can be transmitted to the cornea of a rabbit. The vesicles of herpes corneae febrilis and of dendritis keratitis, however, contain transmissible virus, which has been propagated many generations on the corneas of rabbits, as shown by Gruter and by Lowenstein. Exposure to 56 C. for thirty minutes kills the virus. The virus is ineffective until it has passed the epithelial barrier. (Herpes virus carriers, and the possible relationship between herpes and encephalitis, poliomyelitis and multiple sclerosis were mentioned.) Heavy doses of x-rays are used to relieve pain and reduce the intra-ocular pressure in zoster. For the virus keratitides one or more of the following methods of treatment should be employed: constant blindfold, application of radiant dry heat from an infra-red lamp for fifteen minutes to the exposed cornea, carefully protecting the surrounding skin by moist towels, the Shahan thermophore and applications of 0.5 per cent ethylhydrocuprein.

DISCUSSION

DR. S. B. MARLOWE, Syracuse, N. Y.: I observed four cases of herpes zoster ophthalmicus in which intramuscular injections of arsphenamine were made. It seems only reasonable that some form of medication might be effective if carried to the diseased part, the nerve root ganglion. Arsenic has long been recommended for these cases, usually in the form of solution of potassium arsenate. Its effectiveness, however, has been slow and doubtful. Intramuscular injections of arsphenamine, on the other hand, appear to be much more prompt and certain. Milian reported five cases in which arsphenamine gave prompt relief.

Four patients, all with corneal involvement, were treated by this means in addition to the usual protective measures. The first patient was seen in July, 1929. She complained of severe pain over the right eye, which suggested sinus disease. She was sent to an otolaryngologist who opened the right antrum. The pain continued in spite of this, and shortly afterward the typical eruption appeared on the skin of the upper lip, the right side of the nose and the forehead. A diagnosis of herpes zoster was made and the patient was referred to an internist, Dr. W. A. Groat, who gave her an intramuscular injection of sulpharsphenamine (0.6 mg.). In twenty-four hours the pain was much diminished; in forty-eight hours it was completely relieved. The eruption on the skin cleared within a few days. There had been a large area of epithelial disturbance of the cornea, which healed eventually with an insignificant scar and little visual loss. Three other patients were subsequently treated in the same manner with similar results.

Although four cases are too few to enable one to draw final conclusions, the results obtained were so striking that it has seemed desirable to emphasize the value of this procedure.

DR. J. P. CORSER, Scranton, Pa.: I shall discuss only one type of the disease under consideration, namely, recurring herpetic keratitis. The case histories of at least one form are singularly alike and are about as follows:

There is a sensation of foreign body in the eye, increasing for twenty-four to thirty-six hours, with sensitiveness to light. The eye

feels dry, but usually at the end of the first twenty-four hours during the night there is profuse lacrimation, intense photophobia and the sensation of a large, sharp foreign body on the tarsus of the upper lid. Examination of the eye during the first stage shows a few dilated bulbar conjunctival blood vessels leading to one sector of the limbus, and in the corresponding sector of the cornea, usually near the margin, one or more small superficial infiltrated spots. When the lacrimation takes place, with increased pain and photophobia, these spots stain with fluorescein. These attacks last from seven to twenty-one days and recur at intervals of from one month to one year. During the interval the patients are hypersensitive to light, and use of the eyes for near vision is attended with more or less ocular irritation.

Of nine such cases occurring in our practice, six have now gone more than two years without recurrence. This has been brought about by the avoidance of certain foods, principally shell-fish, port wine, buckwheat flour and tea. It would seem, therefore, that allergy may be a factor in the etiology of this type of hepatic keratitis. The administration of ephedrine by mouth or of epinephrine hypodermatically has given marked relief from the symptoms and has shortened the attacks.

Dr. E. E. Blaauw, Buffalo: Herpes corneae occurs more often than is suspected. I have not seen any case in which the slit-lamp has aided in the diagnosis. I speak only of the dermotropic form. The diagnosis is made eventually with fluorescein, with the addition of methylene blue (methylthionine chloride, U. S. P.).

No recurrence has been observed. I like to think of the herpes virus as something like the pneumococcus, more or less ubiquitous, able to live in a healthy conjunctival sac and giving trouble from time to time. Of course the eye should be closed, but only when the entire diseased epithelium has been destroyed; that is possible by the use of tincture of iodine. I have used it for twenty-five years and have never seen poor results. In most cases the epithelium is restored in two or three days. The patient will complain of much pain for some time after the application of tincture of iodine, but this passes off and can be soothed with anodynes. If the cornea is deeply infiltrated, it is remarkable how the infiltration disappears when the epithelium is restored, leaving hardly any scar tissue, following ordinary routine treatment.

In disciform keratitis the primary cause may be herpes corneae, but I suspect a secondary infection, which accounts for the necrosis of the substantia propria corneae.

Trachoma. Prof. Emil de Grosz, Budapest, Hungary.

In July, 1930, the International Anti-Trachoma League was organized at Geneva. Professor de Grosz was elected president, and Dr. Park Lewis of Buffalo, a representative of the United States in the League, one of the vice presidents.

Trachoma is widespread, a disease associated with poverty, ignorance and close crowding. The chief breeding place is in the family group. Trachoma afflicts 90 per cent of the population of Egypt, and has caused blindness in 4 per cent of the total number in Hungary, and in 15 per cent in Japan. There are about 1,000,000 cases of trachoma in Russia, 700,000 cases in Japan, 400,000 cases in Poland and 100,000 cases in

Italy. Trachoma is prevalent in certain localities of the United States, and 25,000 people were refused admission to the United States by the immigration authorities from 1910 to 1924, because of trachoma.

The bodily constitution does not play a part in the cause of trachoma. It is an infectious disease, and in time the cause will be fully established. Trachoma is distinct from follicular conjunctivitis. The most effective treatment still is silver nitrate in cases showing a discharge, copper sulphate crystals in cases of the papillary type and expression in suitable cases.

Various countries have made progress in combating the disease. Educational measures are of paramount importance. Physicians should receive special training in the recognition and treatment of trachoma. Periodic examinations of the eyes should be made in schools, factories and endemic areas. All cases should be reported, and follow-up treatment should be adequate. Temporary or permanent hospitals should be provided to handle treatments. International cooperation in the matter of immigration is necessary, as is sustained research into the causative agent, the epidemiology and the most effective way to combat the propagation of trachoma.

TRACHOMA. DR. J. A. STUCKY, Lexington, Ky.

I doubt the infectious nature of trachoma, but I believe it to be a deficiency disease, possibly due to vitamin deficiency, which brings about impaired metabolism and an "adenomatous conjunctiva."

TRACHOMA. DR. PETER OLITSKY, New York.

The observations of Noguchi and those who have been continuing his work at the Rockefeller Institute were summarized. *Bacillus granulosis,* discovered by Noguchi, has been found only in cases of trachoma and in monkeys inoculated with its cultures. In monkeys, this organism produces a chronic granular conjunctivitis which resembles human trachoma, except that pannus does not develop. Although gross scar formation was observed in only one animal studied, microscopic search revealed scar tissue in all the animals. Monkeys kept in cages with infected animals develop the same disease as do monkeys in whose conjunctival sacs material from inoculated monkeys is instilled. Inoculation is successful when single subconjunctival injections of cultures or of infected tissue emulsions are made. One chimpanzee was observed for three and a half years after inoculation, and the condition did not clear up.

TRACHOMA. DR. CHARLES WEISS, St. Louis.

There are no definite criteria for experimental trachoma in the monkey, and the histologic picture is unreliable. In work at the Rockefeller Institute 19 per cent of the inoculated animals developed a chronic granulosis lasting over eight months, while 30 per cent showed lesions of shorter duration. In experiments at Washington University, only the briefer lesions were observed, none lasting over four months. The animals used were: twenty-five *Macacus rhesus* monkeys, two Algerian magots and one baboon. Lesions developed in both the magots and the

baboon, showing the greater susceptibility of these animals as compared with *Macacus rhesus*. The long incubation period, up to 106 days, is different from that encountered in human trachoma. Two monkeys inoculated with fresh tissue emulsion from human beings showed a picture much more like trachoma than that produced by *B. granulosis*. Search for agglutinins for *B. granulosis* in the blood of patients with trachoma gave no definite results. The speaker doubts whether the problem of the etiology of trachoma will be solved until a definite picture of experimental trachoma can be decided on.

DISCUSSION OF PAPERS ON TRACHOMA

DR. PAUL D. MOSSMAN, Albuquerque, N. M.: I should like to call attention to the importance of pannus as a means of diagnosis. I believe that pannus is of much earlier occurrence in trachoma than was formerly thought. Pannus is often found early by means of magnification and oblique illumination when other methods do not disclose it. Many cases of folliculosis show the vessels coming down over the limbus, forming a curtain with a straight edge. In early trachoma, however, one often sees a few vessels descending from the edge of the curtain, giving an irregular margin. I feel that this is diagnostic of trachoma.

DR. WILLIAM C. FINNOFF, Denver: We reported the results of our experiments with *Bacterium granulosis* at the meeting of the Section on Ophthalmology of the American Medical Association in 1930. In our paper we stated that we had confirmed in every detail the experimental work of Dr. Noguchi. In addition we isolated the organism from nine of twelve white persons with unquestioned trachoma. All had pannus, scar tissue and unquestioned lesions of trachoma. The organisms were injected into the subconjunctival tissue of monkeys and in a large percentage of instances—larger, I think, than that observed at the Rockefeller Institute—we succeeded in producing conjunctival granulosis. In some cases follicles existed for a period of twenty months; in two, definite evidence of scar tissue occurred, but in none was there pannus. We recently sectioned one of the eyes and lids in which there was newly formed scar tissue. This showed a band of scar tissue and histologic evidence of dense scar tissue formation. Other sections were made and active lesions showed follicles that were identical in appearance with those seen in human trachoma. There was also interfollicular infiltration, which is characteristic of the lesions in trachoma.

We also carried on serologic studies. These experiments were performed exclusively by Dr. Thygeson. The experiments confirmed the results of the last two speakers, in that none of the cases of trachoma showed evidence of agglutination. However, in rabbits that had been given intravenous injections of *B. granulosis*, agglutinin was found in the serum. This agglutinin was specific for certain types of the bacillus, and suggests that there are probably different strains of *B. granulosis*. It is not surprising that negative agglutination is found in cases of trachoma. The disease is confined to a small area in the conjunctiva and in some respects simulates disease of other epithelial structures which do not give positive serologic results. We think that the serologic proof of the presence or absence of trachoma will be difficult and not reliable as a diagnostic measure.

We compared our cases of known lesions with three animals that had spontaneous folliculosis. The lesions produced by *B. granulosis* were much different than those of spontaneous folliculosis.

In the conclusion of the aforementioned paper, we stated that a disease not unlike trachoma was produced in monkeys after the injection of *B. granulosis,* but that the disease was not exactly similar to human trachoma; in order to prove that *B. granulosis* is the cause of human trachoma it would be necessary to inject the organism into the human being.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

W. F. C. STEINBUGLER, M.D., *Secretary*

Nov. 17, 1930

ERNEST F. KRUG, M.D., *Chairman*

MELANOTIC NEVUS OF THE EYE. DR. GUERNSEY FREY.

R. L., a woman, aged 41, had always had a small pigmented mole on the skin of the left upper lid. Thirteen years previously during the course of a pregnancy, the pigmented area on the lid enlarged rather rapidly and then came to a standstill. Five years previously a small black spot appeared on the "white of the left eye" temporally; this spot enlarged suddenly during pregnancy and has been increasing in area during the past two years. The condition was seen for the first time on June 25, 1930. The condition had not changed since, so far as could be demonstrated by measurement and examination. There was an area of pigmentation without elevation that involved the skin of the left upper lid adjacent to the free margin and that continued over the margin to the conjunctival surface of the lid, but that stopped short of the fornix. There was fairly extensive pigmentation of the bulbar conjunctiva, extending from the limbus temporally, below and nasally, and invading the superficial corneal epithelium for a small area below. These pigmented areas on the lid and on the globe were not continuous. The pigmentation seemed to involve only superficial epithelial cells and did not appear to invade any deeper tissue. Examination of the fundus gave negative results. Vision was 6/6 with —1.00 cylinder axis 165. No palpable glandular enlargement was noted.

Dr. A. Benson Cannon, dermatologist, reported as follows (June 25, 1930):

"I think that Mrs. L. has a melanotic nevus. The history of its slow growth, the slight erythema and dilated blood vessels on the margin of the skin of the upper lid indicate that the condition would eventually become malignant. I believe, however, that if all forms of irritation could be avoided, the patient would live many years and perhaps a lifetime without any trouble."

The problem is whether malignancy is to be apprehended either locally or by metastasis, whether such danger can surely be obviated by radical local operation or other method of intervention or whether the

smallness of such risk, the lack of assurance of absolute prevention of malignancy, and the inevitable disfigurement of any operation may not justify a present attitude of observant nonintervention.

RECURRENT PIGMENTED NEVUS OF THE CONJUNCTIVA. DR. JAMES W. SMITH.

H. H., a man, aged 39, was presented before the section because of the similarity of his lesion to that in the patient presented by Dr. Frey. He was first examined on Feb. 16, 1926, following a spontaneous hemorrhage that developed at the site of a nevus of the right bulbar conjunctiva nasally. According to his history, he had noticed a brown spot on the conjunctiva since childhood, and in 1919, following an attack of hay-fever, there was a definite increase in the size of this area. In the history the patient also stated that there were numerous pigmented moles of varying size on the shoulders, thorax, umbilicus and thighs and nine pigmented moles on the posterior aspect of his thorax. There were no evidences of metastases or other physical defects. During the seven years prior to the first examination by me, he had noticed a gradual increase in the size of the mass so that it actually protruded from the palpebral fissure. On February 20, he was admitted to the Post-Graduate Hospital where I removed the tumor mass under local anesthesia. The remaining defect in the bulbar conjunctiva was corrected by sliding flaps. The pathologic report of Dr. Louise H. Meeker, March 1, 1926, was as follows:

The gross specimen measured $10 \times 7 \times 6$ mm. It consisted of a bluish-purple elevation with a surrounding narrow rim of pink mucous membrane. On section, the deep red nodule extended to the base of the specimen. The microscopic sections were covered with stratified squamous epithelium. The stroma beneath was composed of closely packed blood spaces. For the most part the spaces were small; a few were relatively large, and all were separated by abundant, densely-packed nevus cells. Mitotic figures were found among the nevus cells; occasionally there were three in a single oil-immersion field. The pigment was largely blood pigment, but a small amount might have been that seen in pigmented nevi. A diagnosis of markedly cellular nevus was made.

Dr. Meeker stated that the condition would probably recur locally and that it might extend locally. Metastases were not to be expected.

The patient disappeared from observation until Dec. 12, 1929, when he noted a recurrence of pigment on the bulbar conjunctiva nasally and a mass of the conjunctiva extending across the width of the retrotarsal fold. The patient disappeared again until Oct. 23, 1930, when he returned complaining that there was definite fulness in the right lower lid, that the mass in the lower conjunctival sac had increased markedly in size and that the free end was frequently caught between the upper and lower lids at the outer canthus resulting in great pain and occasional hemorrhage.

I intend to excise this mass tomorrow and I should like to ask the members of this section whether the application of radium should be considered in this case postoperatively, or, whether in view of the tendency to malignancy as shown in the early pathologic report, enucleation should be performed.

DISCUSSION

DR. JOHN E. WEEKS: Cases of so-called pigmented nevi in the conjunctiva must always be regarded with suspicion. Almost without exception, they grow. Both of these cases show unmistakable evidence of growth. They are sarcomatous. Unless such growths are removed early and thoroughly, the patient may succumb from the effects of the growth, which occurs in many cases. Early excision, followed by radium, gives good results.

DR. SIGMUND A. AGATSTON: I should like to know what Dr. Smith is going to do with the conjunctiva that extends over the lid, or, if enucleation is to be considered, how would you obviate recurrence in the lid?

DR. JAMES W. SMITH: In this case most of the involvement is on the bulbar or ocular conjunctiva. Enucleation would not arrest the process if the palpebral or tarsal conjunctiva were involved, though local radiation could then be considered as a possibility.

AN UNUSUAL CASE OF MEDULLATED NERVE FIBERS WITH AMBLYOPIA. DR. S. A. AGATSTON.

M. G., a girl, aged 15, came to Bellevue Hospital complaining of poor vision of the left eye. Vision in the right eye was 20/20; in the left eye, 10/200, unimproved. Refraction in the right eye showed emmetropia; in the left eye, myopia —7.00. She gave a history of convergent squint of left eye in early childhood, which was corrected by operation. Examination of the fundus of the right eye gave negative results. The left eye, however, showed medullated nerve fibers of unusual extent. They surrounded the entire circumference of the disk, extended halfway toward the periphery and above the macula in the form of a wide bundle, almost to the ora serrata. The amblyopia was probably caused by other factors of the case. The patient was presented because of the unusual degree of the anomaly.

A BLOOD ASPIRATION CANNULA FOR OPERATION ON THE LACRIMAL SAC. DEMONSTRATED BY DR. HUGH S. MCKEOWN (FOR DR. DANIEL B. KIRBY).

THE OCULAR PATHOLOGY OF NIEMANN-PICK'S DISEASE WITH CHERRY-RED SPOT IN THE MACULA. (LANTERN SLIDES.) DR. DAVID WEXLER (by invitation) and DR. ISIDORE GOLDSTEIN.

This article will appear in full in the ARCHIVES.

DISCUSSION

DR. BERNARD SACHS: Amaurotic family idiocy is characterized histologically by marked changes in the ganglion cells. It is only within the last eight or ten years that it has become known that this condition is really a lipoid degeneration going on in the body of the cells. The interesting fact brought out within the last few years, chiefly through the work of Pick and Bielschowsky (although valuable studies on this disease have been contributed by Schaffer, Spielmeyer, Globus, Kufs, Marinesco, and many others), is that this type of lipoid splenohepato-

megaly has been spoken of as Niemann-Pick disease, or as the Niemann-Pick type of disease, and properly so, I think. From some of the specimens I have seen I believe that there is a great resemblance between the changes that Pick and Bielschowsky described and the changes so many of us have observed in the cells of the central nervous system. Pick was good enough to give me a full demonstration of a series of cases, and I thought then and there that there could not be any doubt as to one fact; that is, that the histologic process in the cells (and by the way, he showed me the cells of the liver, the spleen, the cortex and the spinal cord) in the Niemann-Pick type of disease is entirely identical with the cell changes occurring in the case of amaurotic family idiocy. Before I saw Pick I was not at all sure that this was so, because I went there with some misgiving. I did not think that the two could be merged in any way, but after seeing Pick's specimens and listening to his demonstration, I was no longer in doubt. In that way, I shall probably differ a little from the authors of the paper under discussion, who have given a splendid paper and excellent illustrations. I hope that they will pardon me for going into this, because I think it is the one point of importance. If this lipoid degeneration is restricted to the central nervous system, as it often is, then one will have the clinical picture of amaurotic family idiocy. If the lipoid degeneration spreads beyond the central nervous system, or, excluding the central nervous system, spreads throughout the rest of the body and inundates a number of organs, then we have the type of disease that Niemann and Pick have described. The remarkable resemblance between the two diseases is that they both occur chiefly in children of the Jewish race, that both diseases begin at about the age of 5 months and that the vast majority of the patients die before the lapse of the third year of life. In these factors the two diseases are entirely similar, and another important point is that both of them are family diseases. Particularly since I have known of Pick's and Bielschowsky's work, I have tried so far as is possible to examine all the cases of amaurotic family idiocy that have come under my notice as to the condition of the other organs. I have not seen any pigmentation in the skin in the cases that I have described; I have seen little evidence of enlargement of the liver or spleen, and I have had no case in which I have been tempted to do any puncturing of the spleen in order to prove the thing one way or the other. While I am not ready to have the two diseases merged into one another as yet, I do believe that there is a close identity between the two, and my present feeling, always subject to change with greater experience, is that there is a familial lipoid degenerative disease. If that familial lipoid degenerative disease takes hold chiefly of the central nervous system, one is more likely to have the picture of amaurotic family idiocy. If it either includes or excludes the central nervous system, but takes hold of other organs of the body, then one is apt to have the Niemann-Pick type. From a practical point of view, I believe that the oculists will see more of these cases with the cherry-red spot in which they might be tempted to venture the diagnosis of amaurotic family idiocy and they will generally be right. I think that they will see many more cases of cherry-red spot associated with amaurotic family idiocy than with Niemann-Pick disease, but the two diseases are much alike; the one thing that I rejoice in, if one has any right to rejoice at all, is that the studies that were

begun forty-four years ago, have formed rather interesting associations in the course of the years, and I think that it also shows that although the specialties may seem far apart, ophthalmology, neurology and clinical medicine are closely allied.

DR. KAUFMAN SCHLIVEK: A remarkable thing is that the term amaurotic family idiocy is used in conjunction with this case, and the child was neither amaurotic nor idiotic. The child had the intelligence of an infant of its age. It certainly was not amaurotic; it followed objects definitely and the vision was apparently good. I think that if one could see more of these cases one might be able to say from the clinical picture that this was a case of Niemann-Pick disease in contradistinction to amaurotic family idiocy. The color of the red spot was different from that of amaurotic family idiocy. The spot was larger and it was the color of liver. It was a brownish-red in contradistinction to the cherry-red of amaurotic family idiocy. It did not merge with the surrounding tissue but was definite and clearcut. The tissue around it was gray, instead of the so-called grayish-white one ordinarily sees. I think that if we have the good fortune, or misfortune, to see more of these cases, we may be able from the clinical picture to differentiate them from cases of amaurotic family idiocy.

DR. DAVID WEXLER: We should like to stress the yellow color of the head of the nerve as being perhaps the most indicative appearance in the fundus. Its origin is probably the deposit of lipoid in numerous cells in the nerve, which we have demonstrated. This, rather than the size and color of the spot at the macula, could be looked for in future cases as a possible means of differentiation from Tay-Sachs disease.

We have avoided the term, amaurotic family idiocy, in this case, as retarded mental development and amaurosis are as typical of Niemann-Pick's as of Tay-Sachs disease. If this child were mentally normal for its age, its case would be unique in this respect among all the cases of Niemann-Pick's disease thus far reported. However, at 10 months, the psychiatrist reported a mental age of from 3 to 6 months. As regards the vision, the universal degeneration of nerve cells in the brain would be sufficient to preclude vision, let alone the extensive lesion at the macula. Furthermore, the sections show atrophy of the nerve.

SOCIAL SERVICE AT THE MASSACHUSETTS EYE AND EAR INFIRMARY.

DR. GEORGE S. DERBY, Boston (By Invitation).

Eye social service started at the Massachusetts Eye and Ear Infirmary in 1909 and probably is now developed further than in any eye hospital in the country. At first it consisted in personal contact with the patient and his family, follow-up and liaison with outside agencies that could be of assistance. These are the fundamental duties of social service. As time went on, workers increased and more funds became available, it became possible to do intensive work on special classes of cases. Thus work has been done on ophthalmia neonatorum, phlyctenular disease and adult tuberculosis of the eye, interstitial keratitis and finally, during the past three years, on glaucoma. As a result, the number of cases of glaucoma at the infirmary has tripled (from 250 to 740), and the operations for this disease have doubled in number. There is need for intensive work to be done on myopia. The availability of

social service has enabled the hospital to handle its patients with greatly increased efficiency. The importance of this service as a potent weapon in the prevention of loss of vision and blindness is stressed.

DISCUSSION

MISS AMY SMITH: (Miss Smith gave illustrative cases showing various of the problems encountered in hospital social service work, and demonstrated the usefulness of social workers in eye hospitals.)

DR. JOHN M. WHEELER: I think that since I started in ophthalmology the most important development that has taken place has been this development in the social service work. I am considering the time when the New York Eye and Ear Infirmary and other institutions had done no social service work. It was through the interest that Dr. Derby has shown and through his presentation of the subject that it came up, and I think that his maintenance of interest in this important subject has been responsible more than anything else for the development of social service work in the different hospitals through the country and in the eye clinics. I think that we are probably still lagging behind Boston. As far as I know, the different social services in the New York hospitals have not taken up special subjects and followed them anywhere near as searchingly and as thoroughly as has the social service at the Massachusetts Eye and Ear Infirmary. Dr. Derby and his staff have taken up the subjects that have been mentioned here and he has expressed his appreciation of the importance of the work on glaucoma. We have not gone as far as that in New York. I hope that we will gather new inspiration from Dr. Derby's presentation and follow more closely the methods that the Social Service of the Massachusetts Eye and Ear Infirmary have followed. As an example I wish that Dr. Derby would say how he intends to develop social work in myopia. The specialist has been described as a man who knows more and more about less and less, and I think that Miss Smith will agree with this definition from what she said about the physicians, but social service work really should not be, and cannot be, a thing apart from the work of the physician. The work of the doctor and that of the social service worker should be closely coordinated. I think that they are becoming more and more so. Now we take for granted the work of the social service department in various hospitals. When I first took up ophthalmology one used to prescribe a great many placebos; one gave drops and internal medication when one did not know what to do with the patient. Now one knows that the social service worker can go on with the work that one would like to have done. I should like to hear from Miss Smith about the financial help that she and her co-workers in the Massachusetts Eye and Ear Infirmary mentioned. In speaking with Miss Thornton, the head of the Social Service at the Presbyterian Hospital, she said, "Perhaps the most interesting and valuable thing we social service workers can do is to get the patient to help himself," and the social service workers there have been surprised at the large number of cases in which it is possible by taking up one point after another to get the patients to find a way to help themselves. If this can be done, no finer thing can be done for patients. I should like to hear from Miss Smith how the financial part of the help to the patient is provided,

whether usually by loans to the patient or whether by gifts, and if by loans, in what proportion of the cases are the loans returned by the patients. In other words, how favorably do they respond to helping themselves?

DR. CONRAD BERENS: After comparing the efficiency of hospital and clinic work in New York with and without social service, I am sure that Dr. Derby has not overestimated its importance. A study of the clinic records of ten hospitals in New York and Brooklyn proved that in clinics with no social service, 98 per cent of the records were without value for the purposes of clinical research and teaching, and that they gave insufficient information for the proper continued treatment of the patient.

DR. ISAAC HARTSHORNE: Our social service worker at St. Luke's has made herself absolutely indispensable to the running of the clinic, and those of us who were there before she came really cannot compare the work we were able to do then with the work that we are able to do now with her assistance. Of course, the individual personality of the social service worker makes an enormous amount of difference in the results.

DR. GEORGE S. DERBY: Dr. Wheeler asked what we would do with the cases of myopia. The patients usually come to us, as you all know, when they are 40, or 45, or 50 years of age, and there is almost nothing that we can do. We say to ourselves, "Why did you not come to me thirty or forty years ago, when I could have done something for you?" We want to follow up all of those cases, and we want some part of a social worker's time to put on them so that those in whom high myopia is developing will be placed in an environment suitable to them, and so that a suitable occupation will be chosen when the child graduates from school, and so that they can be watched carefully and instructed in what they can and cannot do, with this disease of the eyes. I think that such a procedure would be well worth while, and that we could save a certain amount of eyesight.

Directory of Ophthalmologic Societies *

FOREIGN

British Medical Association, Section on Ophthalmology

President: Mr. E. E. Maddox, Glenartney, Poole Road, Bournemouth, England.
Place: Eastbourne. Time: July 22-24, 1931.

Oxford Ophthalmological Congress

Master: Dr. A. B. Cridland, Salisbury House, Chapel Ash, Wolverhampton, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 Avenue de La Motte Picquet, Paris 7è.
Place: Paris. Time: May 4-7, 1931.

NATIONAL

American Medical Association, Section on Ophthalmologgy

Chairman: Dr. George F. Suker, 25 E. Washington St., Chicago.
Secretary: Dr. William C. Finnoff, Imperial Bldg., Denver.
Place: Philadelphia. Time: June 8-12, 1931.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. William H. Wilder, 122 S. Michigan Ave., Chicago.
President-Elect: Dr. J. F. Barnhill, Miami Beach, Fla.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: French Lick, Indiana. Time: Sept. 14-19, 1931.

American Ophthalmological Society

President: Dr. Arnold Knapp, 10 E. 54th St., New York.
Secretary: Dr. Emory Hill, Professional Bldg., Richmond, Va.
Place: Asheville, N. C.: Time: June 3, 1931.

SECTIONAL

New England Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Me.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. Chester H. Bowers, 1136 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Albert E. Hillis, 1115 Pacific Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Fletcher D. Woodward, Box 162, University, Va.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: New Orleans. Time: November, 1931.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Wilfrid Haughey, 65 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. H. Fraser, Battle Creek Sanitarium, Battle Creek.
Time: Third Thursday of alternate months.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Donald H. O'Rourke, 217 Imperial Bldg., Denver.
Place: First floor, Metropolitan Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Dorland Smith, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: W. L. McDougall, 50 Whitehall St., S. W., Atlanta.
Secretary-Treasurer: Dr. William O. Martin, Jr., 412 Medical Arts Bldg., Atlanta.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John W. Carmack, 23 E. Ohio St., Indianapolis.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John C. Brown, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Hendrie W. Grant, Lowry Bldg., St. Paul.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Lee W. Smith, 125 W. Granite St., Butte.
Secretary: Dr. J. G. Parsons, Lewistown.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. B. Beeson, 232 W. De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. W. McCollom, 346½ Washington St., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Raymond F. Hacking, 105 Waterman St., Providence.
Secretary: Dr. Herman A. Winkler, 224 Thayer St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

Utah Ophthalmological Society

President: Dr. Franklin H. Raley, 9 Exchange Pl., Salt Lake City.
Secretary-Treasurer: Dr. H. Leroy Smith, 1005 Medical Arts Bldg., Salt Lake City.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Fletcher D. Woodward, Box 162, University.
Secretary-Treasurer: Dr. Henry Grant Preston, Harrisonburg.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. S. S. Hall, Fairmont.
Secretary: Dr. G. A. Smith, Montgomery.
Place: Clarksburg. Time: May 19-21, 1931.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

Chairman: Dr. J. Wallace Hurff, 86 Washington St., Newark.
Secretary: Dr. Earl LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

Academy of Medicine of Toronto, Section of Ophthalmology

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W. Toronto.
Time: First Monday of winter months.

Atlanta Academy of Ophthalmology and Oto-Laryngology

President: Dr. John R. Childs, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society. Section on Ophthalmology

Chairman: Dr. Angus Lloyd MacLean, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John N. Evans, 23 Schermerhorn St., Brooklyn.
Secretary: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday of February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. A. F. Luhr, 40 W. North Ave., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. William V. Mullin, 9204 Euclid Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 2064 E. 9th St., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. W. E. Burner, Guardian Bldg., Cleveland.
Secretary: Dr. M. P. Motto, Rose Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Maxwell Langdon, 1530 Locust St., Philadephia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. A. M. Hauer, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Albert D. Frost, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Decherd, 1717 Pacific Ave., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, 1717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. G. G. Marshall, 122 West St. Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday of October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. J. J. Richardson, 606 Penn St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Needham, 1304 Medical Arts Bldg., Forth Worth, Texas.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Claude C. Cody, 1306 Walker Ave., Houston, Texas.
Secretary: Dr. J. M. Robison, Eye, Ear, Nose and Throat Hospital, Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. E. L. Lingeman, 241 N. Pennsylvania St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Secretary: Dr. O. S. Gilliland, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dean E. Godwin, Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Ferris Arnold, Security Bldg., Long Beach, Calif.
Place: Pacific Coast Club. Time: Last Wednesday of each month from September to June.

LOS ANGELES COUNTY MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Eugene R. Lewis, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 727 W. 7th St., Los Angeles.
Place: California Lutheran Hospital, Assembly Room. Time: 8 p. m., first Monday of each month from October to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Dr. James A. Flynn, 1511 Rhode Island Ave., Washington.
Secretary: Dr. E. R. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. Herbert F. Wolters, 130 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. W. R. Buffington, 211 Camp St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. E. F. Krug, 12 W. 44th St., New York.
Secretary: Dr. William F. C. Steinbugler, 815 Park Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. George B. Potter, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. J. C. Davis, 425 Aquila Court, Omaha.
Place: Medical Tea Room. Time: 5:15 and 7:00 p. m., third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. Clyde Heatly, 11 N. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. John F. Gipner, 53 S. Fitzhugh St., Rochester, N. Y.
Place: Rochester Medical Assn., 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

St. Louis Ophthalmic Society

President: Dr. Martin H. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

San Antonio Ophthalmolo-Oto-Laryngological Society

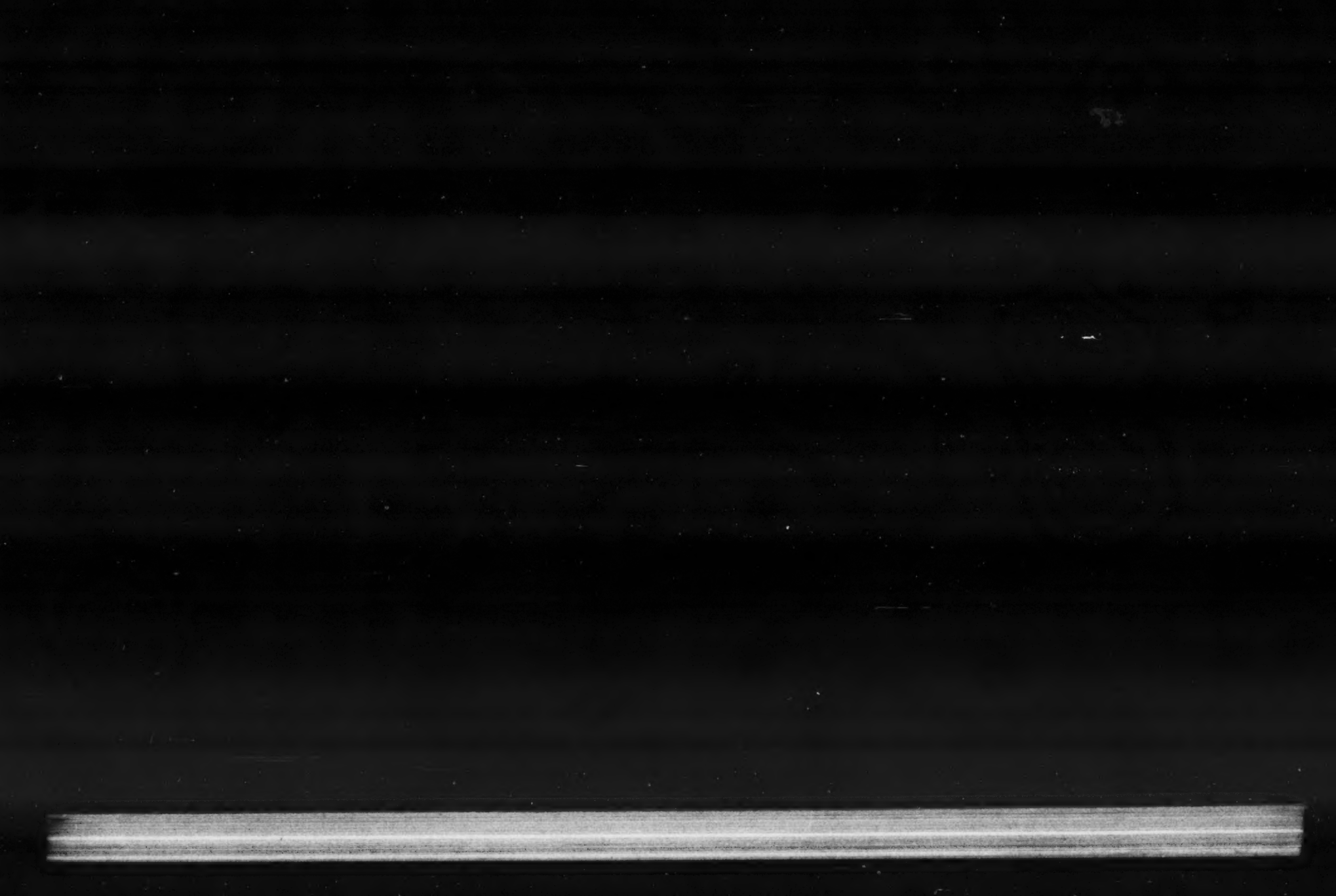
President: Dr. T. J. Walthall, 728 Main Ave., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. W. F. Swett, 693 Sutter St., San Francisco.
Secretary: Dr. Robert C. Martin, 384 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul A. Remington, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Searle B. Marlow, State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. A. Harry Rubenstein, Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.